POWER

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Sir Isaac Newton

THE world has been celebrating the two-hundredth anniversary of the death of Sir Isaac Newton.

Two hundred years. Less than three times the allotted life of man; but what progress the world has made in that time in the path that he pointed out for it!

He owned up to being a poor scholar and stood low in his classes until one of the schoolfellows picked upon him so badly that Newton got mad and licked him.

It was a good thing for Newton to get mad. It broke up his inferiority complex and he went to the head of the class.

Another fortunate thing for Newton was that while at the grammar school he boarded at the house of an apothecary—a man who had books and knowledge and encouraged Newton's love for mechanics and mathematics.

When he was fifteen his stepfather died and he was taken out of school, apparently to farm the small property that his own father had left.

But on market days, when he went to the neighboring town where the school was, he spent his time among the books in the house of the apothecary.

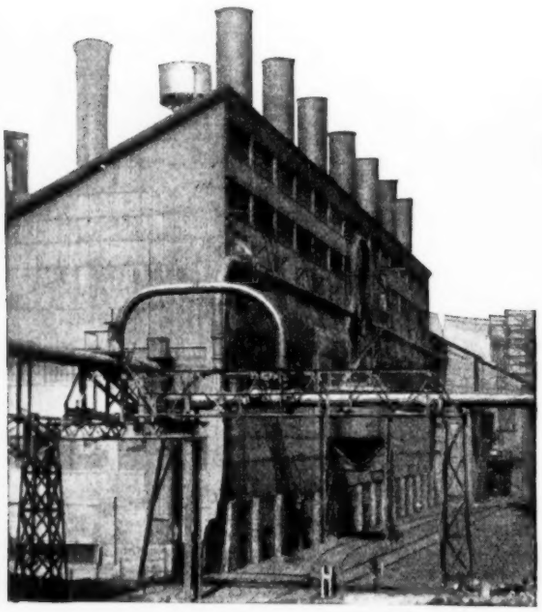
They finally concluded that it would be a mistake to try to make a farmer out of him, and he was sent back to school and to college.

A book on astrology incited his interest in mathematics. He could not understand one of the figures of the heavens in it on account of his lack of knowledge of trigonometry. He found Euclid too obvious and passed on to Descartes and to the winning of his triumphs as a mathematician and a natural philosopher.

Probably something else would have jarred Newton out of his contented inferiority; probably something else would have activated a mind like his to an exposition of the mechanics of the universe; but on the record the world is indebted to that fellow who needed a licking and to the interest aroused by the speculations of an astrologer for motivating one of the greatest minds and personalities that the race has produced.

Trend in Steel Plant Power

Seen in New Plant and Electrification at the Colorado Fuel and Iron Co.



Each boiler has its individual stack

By H. W. Neblett*

EXECUTIVES and engineers in steel plants realize that while power and steam costs represent only a small percentage of the total cost of producting finished steel, the total annual cost of these items amounts to an enormous sum, and the possibility of large returns from investments in modern power plants and electric mill drive equipment is assured.

Some Features

ONE HUNDRED AND EIGHTEEN boilers replaced by seven through the installation of this new centralized power plant, containing also three 10,000-kw. turbine-generators and four blowers which replace a number of scattered steam-engine plants and drives throughout the mills.

Since electric drive has been installed, the mills have repeatedly broken all previous tonnage records. In addition a large saving in operation has been accomplished, through reduction in fuel, labor and maintenance.

Both blast-furnace gas and powdered coal are burned, the latter being used for short periods at high ratings, and not continuously. Therefore, the pulverizing capacity is comparatively small and a centralized pulverizing system is employed.

The plant is situated in a section where the water supply is limited, hence all the water used in the steel plant is first passed through the condensers at a pressure of 50 pounds.

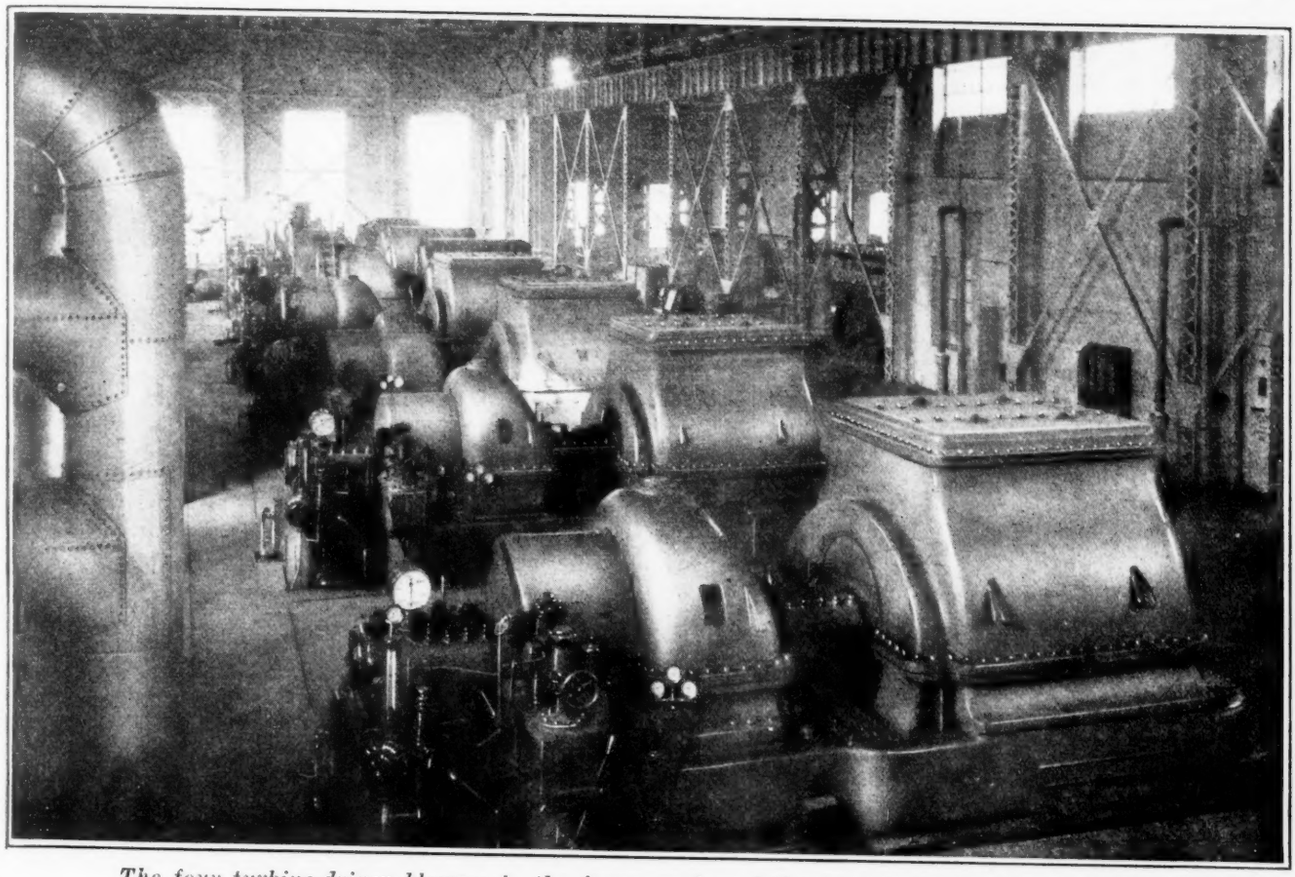
A Cottrell system of electric precipitation has been installed for cleaning the blast-furnace gas. In this case the gas is cleaned to an average of 0.2 grain of dust per cubic foot.

THE average steel plant engaged in the production of pig iron, the manufacture of steel and the rolling of the various steel products, is favorably situated for utilizing a modern steam-driven electric generating plant. Fuel is available in the form of blast-furnace gas and, in most cases, other fuel, such as coke braize and slack or screenings from coal. The rolling of steel products requires large quantities of electric power, and the number of mills is usually great enough and the loads so diversified that a large and fairly constant electric load is available during the twenty-four hours of the day. Blowers are required for supplying air to the blast furnaces, and where these are steam-turbine driven they can be installed in the power house with the turbine-generators, thus insuring a more diversified and steady steam demand.

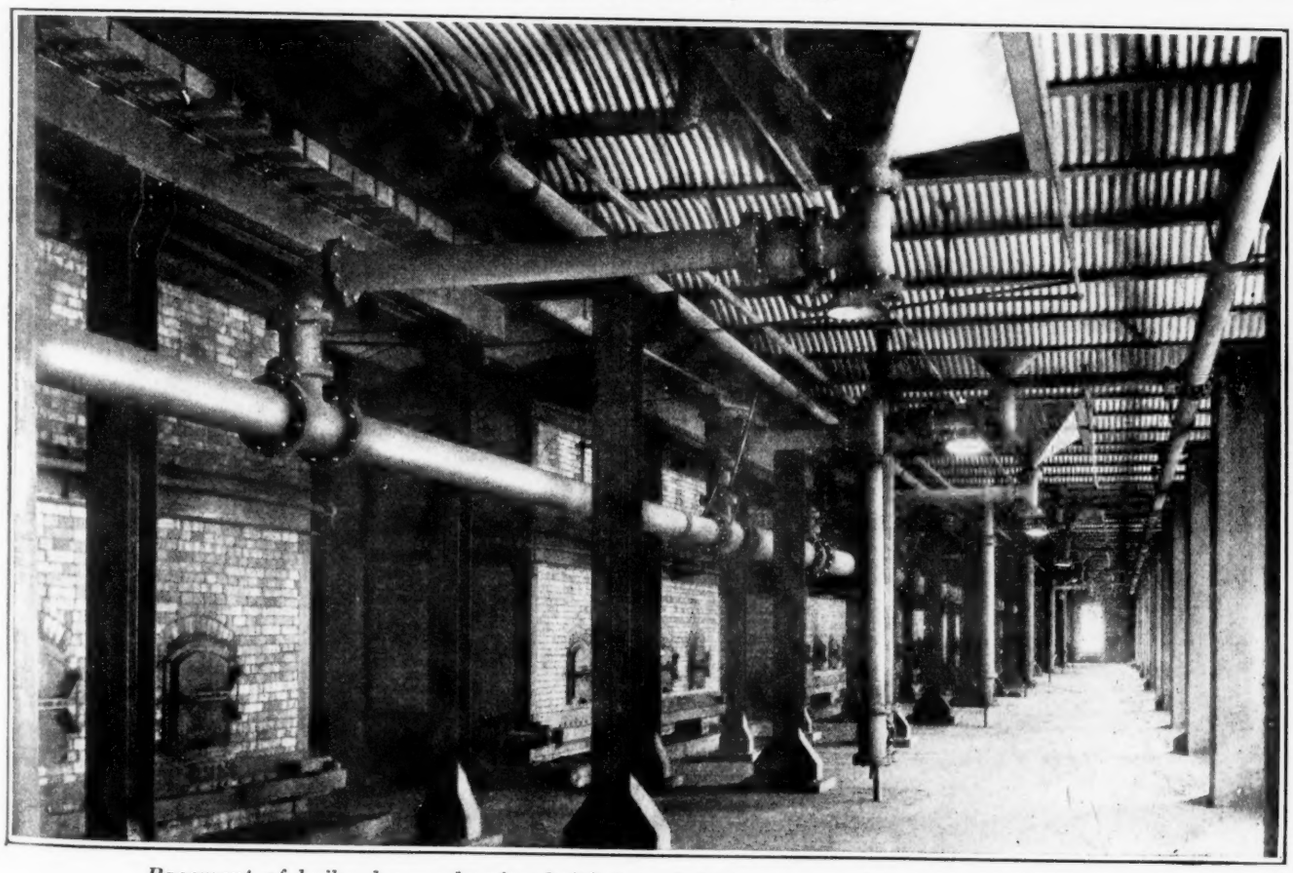
Many steel plants are abandoning the various scattered steam-engine drives with their isolated boiler plants, low steam pressure, high labor and maintenance costs, and poor efficiency, and are installing electric motor drives for the mills, supplied with power from a centralized power plant.

The Colorado Fuel & Iron Company has followed this trend by recently installing a power plant and electric drives for its mills in the Minnequa Steel Works at Pueblo. This power plant has made possible great savings in the production of steel by the elimination of many steam engine drives and isolated boiler plants. A total of 75 boilers in five boiler plants have been eliminated to date, and when the electrification program, for which the new power plant is designed, has been fully extended, a total of 118 boilers will have been abandoned. The new power plant, in its relations to the other departments of the steel plant, is operated as a

*Chief engineer for Wilfred Sykes, consulting engineer, Colorado Fuel and Iron Co.



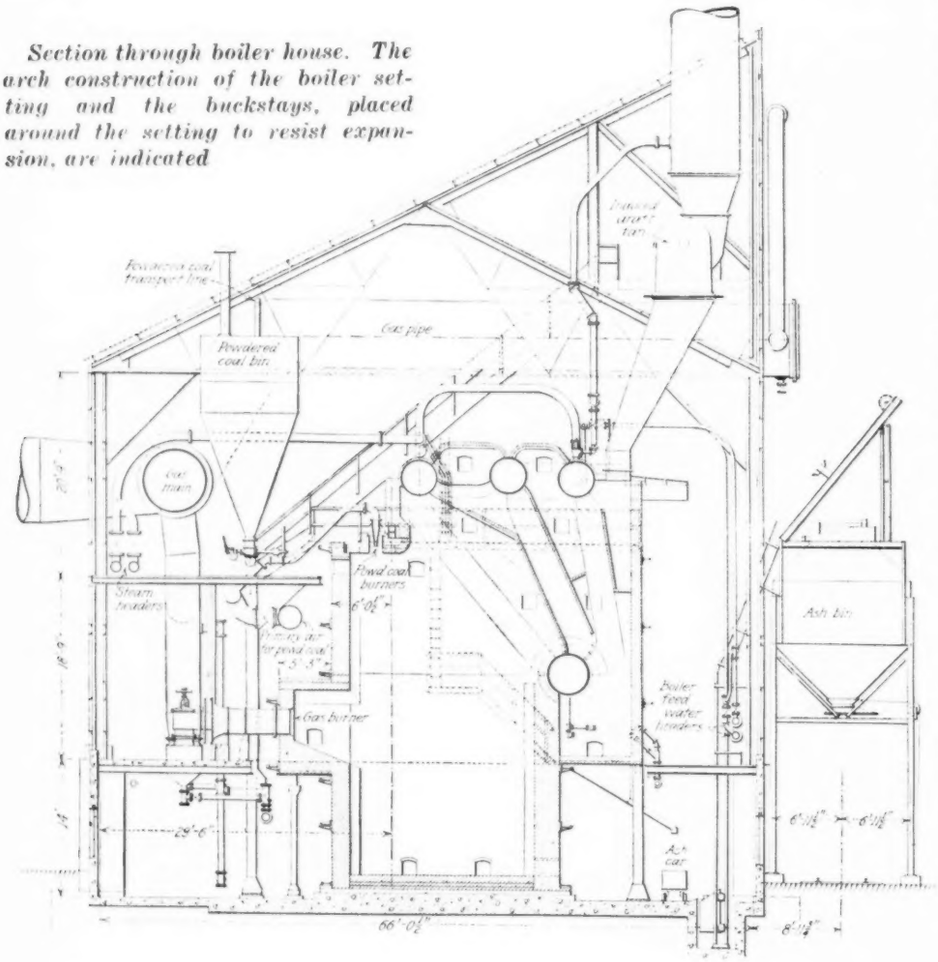
The four turbine-driven blowers in the foreground, and three 10,000-kw. turbine-generators, create a steady demand for steam



Basement of boiler house showing brickstays, held by compression springs, around boiler settings to resist expansion

utility, purchasing fuel in the form of blast-furnace gas or coal and selling electric power, steam, blast air and water.

Two main turbine-generator units are installed and a third is in the course of erection. These units are each rated at 10,000 kw. (12,500 kva.), 6,600 volts, three-phase and 60 cycles. The generators have closed cooling systems with thermostatically controlled doors which open and admit fresh air in case the temperature of the circulated air becomes excessive.



Section through boiler house. The arch construction of the boiler setting and the buckstays, placed around the setting to resist expansion, are indicated

The generators are connected to a main 6,600-volt bus to which is connected the main power feeders to the mills and a tie line to the Southern Colorado Power Co., for the exchange of power.

Four turbine-driven blowers are installed for supplying air to the blast furnaces and are so connected to the cold blast lines leading to the stoves that any blower can supply any one of three furnaces. These blowers are rated at 55,000 cu.ft. of air per minute at 25 lb. pressure for the altitude at which they are installed, namely, 4,800 ft. This corresponds to a rating of 60,000 cu.ft. at sea level.

The auxiliary equipment consists of two 150-kw. motor-driven, and one 150-kw. steam-driven exciters, two 1,000-kw. 250-volt direct-current motor-generator sets feeding the direct-current power system of the steel plant adjacent to the power house, and two 220-kw. dual drive, 250-volt direct-current generators for supplying power to the various direct-current motors of the power house, powdered-coal plant, and gas cleaning plant. These dual drives not only insure uninterrupted power for station use, but also furnish exhaust steam as required, in addition to that from other sources, for the boiler feed water treating and heating equipment. Each dual drive set consists of a direct-current generator directly connected to and driven by a 2,300-volt alternating-current motor and a non-condensing steam turbine. The turbine is equipped with a regulating governor which will automatically take the entire load on the turbine in case the power supply to the motor fails. Also, by means of a regulating valve any portion of the load may be taken on the turbine. In this way a varying amount of exhaust steam may be furnished for boiler feed water treating as required.

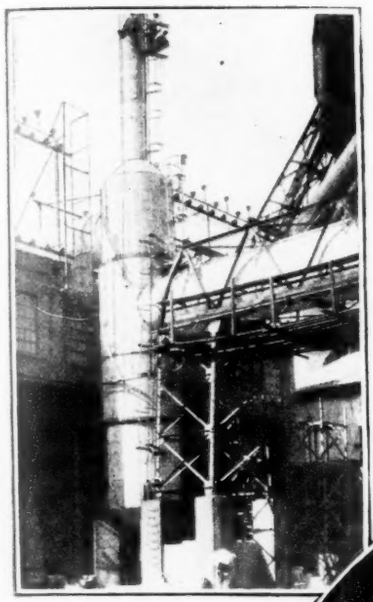
From the reserve feed-water tank feed water is delivered to a deaërator, connected with the vaporators for treating the raw makeup water. The feed water is deaërated to the extent that the oxygen content is below 0.05 c.c. per liter. From the evaporators and deaërators water is delivered to the boiler-feed pumps at approximately 205 deg. F.

There is also installed a soda-lime hot-water softening plant for supplying feed water to the low-pressure boilers which furnish steam at 150 lb. for general use. The steam for the two boiler feed water treating plants is supplied by the exhaust from the boiler feed pump turbines, the steam-driven exiter, and the turbines on the dual-drive sets. This exhaust steam has a maximum pressure of 10 lb.

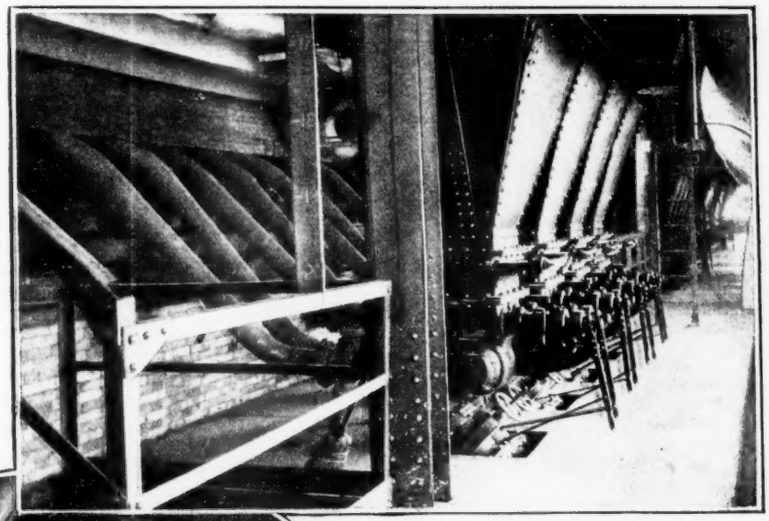
The water used by the steel plant is approximately 32,000,000 gal. per day. This is delivered by gravity at 50 lb. pressure through pipe lines from storage reservoirs approximately five miles away. The system is so arranged that all the water for the main steel plant is first passed through the condensers of the turbine-blowers and turbine-generators.

Seven 12,000-sq.ft. Stirling type boilers, without economizers, are installed. These are designed for 330 lb. and 200 deg. F. superheat. Until such time as all the present steam-consuming units in the mill are replaced with electric drive, one and sometimes two boilers will be operated at 150 lb. The settings are solid brick walls, no air cooling being provided. The inside walls are of arch construction, so designed that expansion causes the wall to tend to move outward. This outward movement is taken care of by a steel framework of buckstays held together with heavy springs under compression. These springs allow sufficient movement of the steel binding to conform with the expanding of the setting. This boiler setting is believed sufficiently flexible to prevent cracks through the walls; also the arched construction of the inside or

Views Around Fuel Preparation Plant



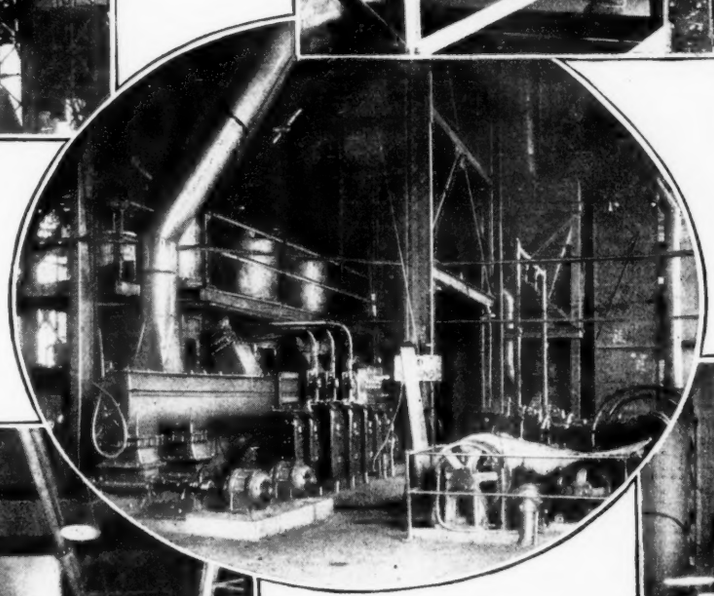
Above—Gas cleaning plant

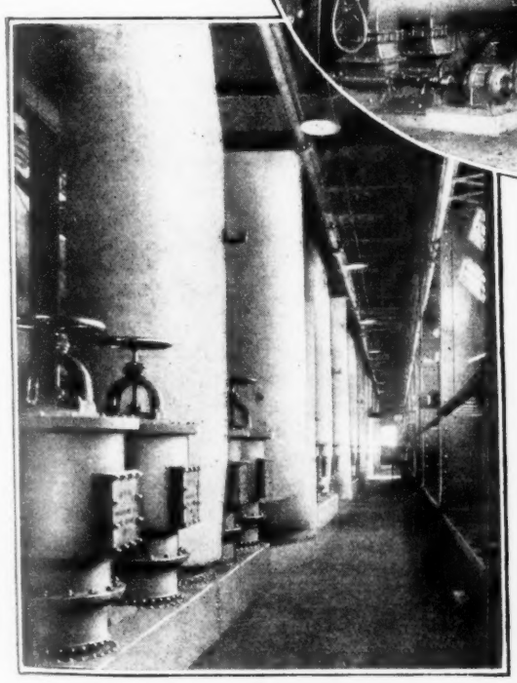


Above—Powdered coal bins, feeders and connections to burners

Left—General view of coal pulverizing plant

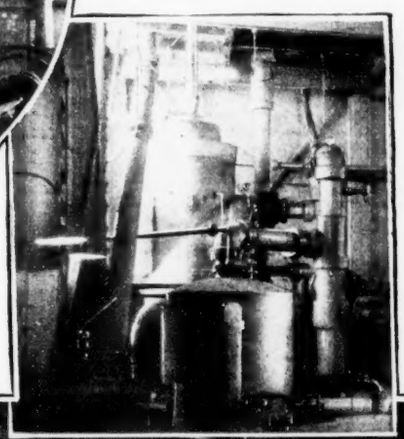
Below — Boiler feed water treating apparatus

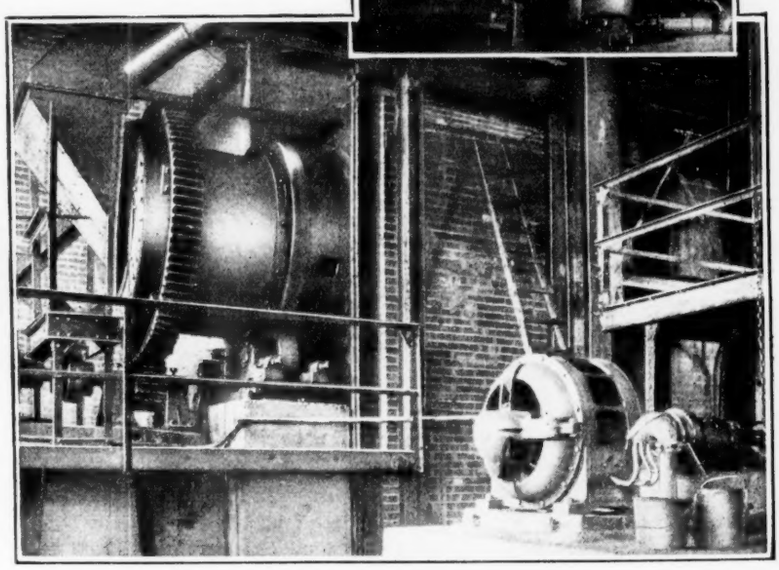




Above—Gas burner valves and gas main connections

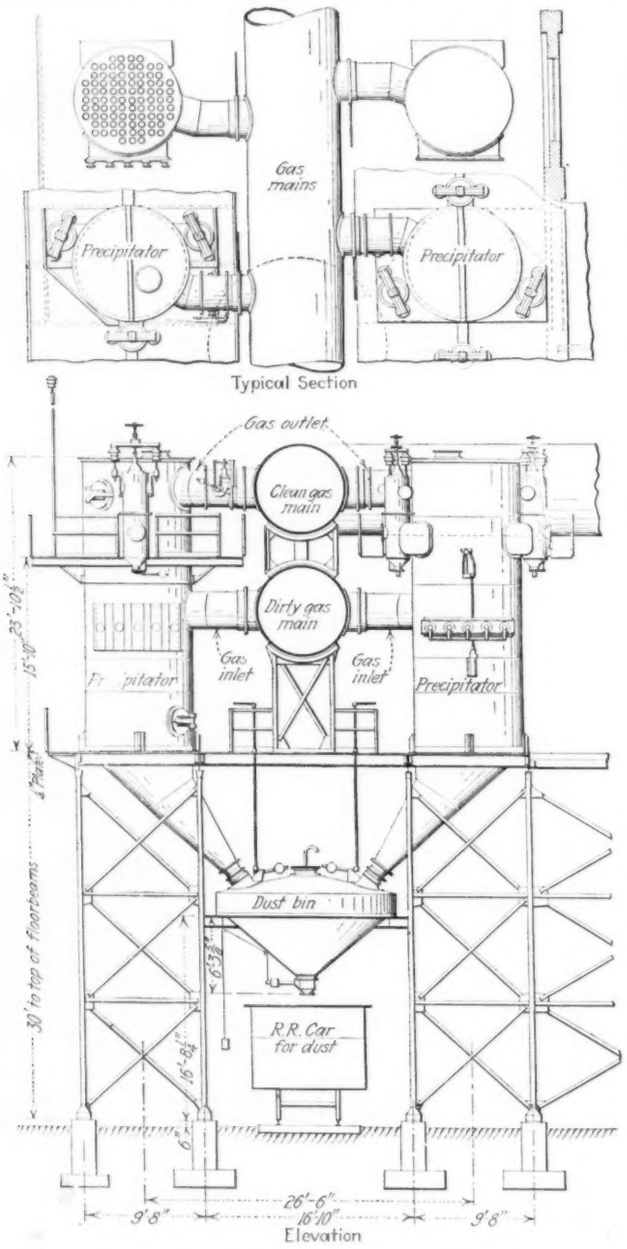
Right — In the coal pulverizing plant, showing raw coal drier





combustion face of the walls tends to hold the bricks together under expansion and prevent cracks.

Both blast-furnace gas and powdered coal are used. Two boilers are equipped for burning blast-furnace gas only, and five for burning both blast-furnace gas and powdered coal. Owing to the method of cleaning, the gas is delivered to the boilers at an average temperature of 375 deg. F. Powdered coal is used only when there



Arrangement of gas cleaning apparatus

is a shortage of gas and for short periods during blast-furnace cast.

There are eight powdered-coal burners per boiler, located near the top of the combustion chamber and 17 ft. above the gas burners. They fire vertically. Powdered coal is fed to the burners by screw feeders driven by adjustable speed direct-current motors, the control of which is located on the operating floor. Approximately 30 per cent of the air required for combustion is delivered under pressure through the burners with the coal, the additional air being admitted through three rows of air doors in the front wall of the setting.

A central pulverizing plant with a capacity of 18 tons per hour (containing three 6-ton ball screen mills) is installed in a separate building, approximately 100 ft. from the boiler house. This system was decided on rather than a unit system for each boiler on account of less total pulverizing capacity required; the elimination of raw coal conveying and storage equipment in the boiler house, and greater flexibility. Since powdered coal is used mainly as an auxiliary fuel, comparatively little coal is required over a period of a day or week, but the demand may be heavy for short periods due to a shortage in gas supply when furnaces are casting or are down for changing tuyeres, etc. With a central coal-pulverizing system and powdered-coal storage bins at the boilers, these heavy demands can be handled by comparatively small pulverizing equipment.

Gas-Cleaning Plant

The gas contains approximately 98 B.t.u. per cu.ft. It leaves the blast furnaces at about 400 deg. F. and contains an average of 4 grains of dust per cubic foot; at times this will be as much as 6 grains.

A Cottrell Electric Precipitation Process has been installed for cleaning the gas. In this the gas passes through tubes or between partitions, in the center of which are suspended small wires that are insulated from the tubes or partitions. A high voltage uni-directional current is applied to the wires, and the particles of dust in the gas pick up a charge when passing through this zone and are deposited on the walls of the tubes or partitions. At regular intervals of approximately once an hour the current and gas are cut off from each unit and the tubes or partitions rapped, which causes the dust to drop into the lower part of the cleaner.

The cleaned gas contains an average of 0.2 grain of dust per cubic foot, and this figure can be reduced to any amount desired by reducing the flow of gas through the precipitators. The gas is cleaned without reducing the temperature, which adds approximately 3 per cent to its heating value. The total power required for operating the gas cleaning plant is 80 kilowatts.

The 6,600-volt alternating current is distributed on individual lines to each mill or department. The 250-volt direct current is distributed into a general direct-current distribution system for the plant. The motor-generator sets in the power house supply direct current to that part of the system in the vicinity of the power house. They also connect by means of tie lines to other centers of direct-current distribution, such as the Rod Mill, in which two 1,000-kw. 250-volt direct-current motor-generator sets are installed.

The electrification of this steel plant has resulted in a great saving of fuel, maintenance, labor, and operating costs, the saving in coal alone amounting to over 150,000 tons per year, and this will be further increased with the extension of the electrification.

Increased production has resulted from the installation of electric drive. Every mill electrified has exceeded all previous production records since electric drive has been installed. Mill speeds remain the same as originally, but the increased production is due to a more uniform mill speed being maintained than was possible with steam-engine drive.

The power plant and steel plant electrification was designed, and its construction supervised, by Wilfred Sykes, consulting engineer, Chicago.

The Steam Loop *and* How It Operates

EVEN engineers using this well-known system for conserving steam line condensation do not understand how it works. It operates without employing any of the commonly used apparatus or moving parts.

AS A method of returning pipe-line condensations to the boiler, the steam loop has long been known. It consists of an insulated riser *A*, Fig. 1, connecting the point to be drained to a horizontal condenser located considerably above the boiler and a drop-leg *B*, also insulated, connecting the condenser with the boiler drum below the water line. The condenser is pitched so as to drain water collected in it to *B*.

When steam is not flowing in the main from the boiler, the pressures in the condenser and boiler will be the same, and it is evident that water will rise in *B* to the same level as the water in the boiler drum. However, when steam is flowing in the main from the boiler, a pressure drop is caused by friction between the steam and the pipe, and therefore the pressure in the condenser is less than the pressure in the boiler. Water will now rise in drop-leg *B* until the weight of

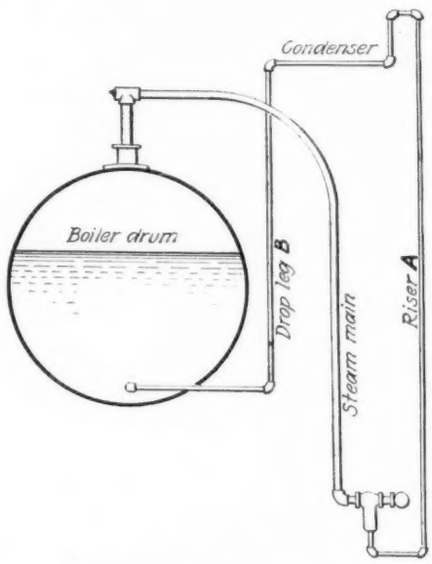


Fig. 1—Simple Steam Loop

water above the level in the boiler drum is sufficient to balance or equal the difference between the drum pressure and the pressure in the horizontal condenser.

Since the horizontal pipe is bare, there will be a considerable amount of steam condensing in it. This condensation will cause a reduction of pressure and hence a flow of steam from the main up to the condenser. The steam flow will entrain with it any moisture or condensation that may have collected in the drip pocket and carry it to the condenser. As the steam loses its velocity in the horizontal, the water and moisture carried by it will separate from the steam and drain into the drop-leg, adding to the water already in it. This addition of water increases the head above that required to balance the difference in pressure between the boiler and the condenser, and because of the increased head the added water will flow into the boiler.

This simple steam loop is not suitable for large installations and has been supplanted by the Holly gravity return system, which is capable of handling the drips collected from the steam piping of large plants, including central stations.

In principle the "Holly System" is identical to the simple steam loop. The piping interconnections peculiar

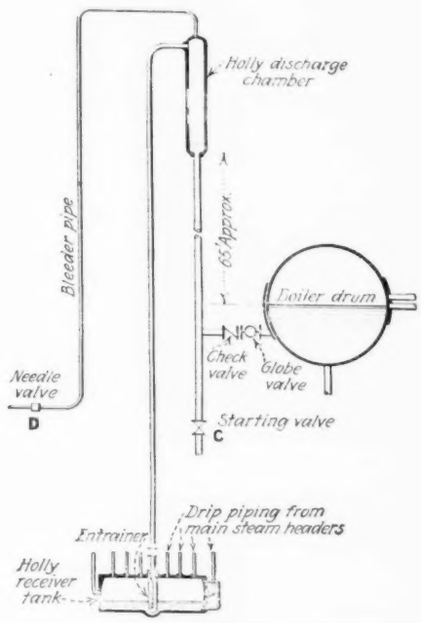


Fig. 2—Holly Steam Loop

to it are shown in Fig. 2. Drips from various drain connections to the station steam piping are collected by gravity in the receiver shown in the diagram. The piping system which collects the drips must be pitched to the receiver or "pig," as it is sometimes called, and the receiver must be located below the lowest point from which it is desired to collect drips in order that the condensation will drain to the receiver. Gate valves at the drain connections to the steam main are the only valves necessary in the piping system. No definite rule can be laid down for determining pipe sizes in the collecting system, as the quantity of drip to be collected is usually an unknown factor. In general, however, 1-in. drip connections to the steam main and 1½-in. headers will be found adequate.

In the receiver tank is a special U-shaped fitting extending to the bottom of the tank. One leg of the U is perforated and open at the top. The other leg is brought out through the top of the tank and connected by a riser to the side of a discharge chamber, as shown in Fig. 2.

This chamber must be installed at an elevation well above the boiler drums to which it is connected. The drain line from the bottom of the chamber is connected to several boilers in order to insure one operating boiler always being available to receive the drip return.

The ¾-in. bleed connection from the top of the discharge chamber may be piped to a feed-water heater or any convenient apparatus which can use a small continuous flow of saturated steam.

To place the system in operation, the starting valve *C*, Fig. 2, is opened until a steady flow of steam appears, thus clearing the system of air and condensation. The regulating valve *D* in the small bleed line is next opened, allowing steam to flow from the discharge chamber and thus reducing the pressure in it. This reduced pressure causes steam to flow from the receiver or "pig" through the riser to the discharge chamber.

Condensation collected in the receiver tank will spray through the perforations in the special U-shaped fitting, where it will be entrained by the steam flow and carried up through the riser to the chamber above. Here the steam and water separate, the drip falling to the bottom of the chamber, the steam escaping through the bleeder line. A picture of what is happening in the riser can be obtained by observing the ordinary coffee percolator. Here steam generated at the bottom of the riser carries up with it slugs and bubbles of water to the chamber above the coffee. In the chamber the water separates from the steam and drains back through the coffee into the pot below, while the steam either condenses or escapes through a vent in the top.

In lifting the drip to the elevation of the discharge chamber, little pressure head is lost, so that nearly station header pressure exists above the water collected in the discharge chamber. Water collecting in the chamber and its drain piping will drain into the boiler drum in the manner described for the simple steam loop.

The height above the boiler drums to which the water in the discharge chamber must rise before balancing boiler pressure will seldom exceed sixty-five to seventy feet. The required elevation may be arrived at as indicated in the following illustration: Assuming the pressure drop through the superheater at maximum boiler rating to be 9 lb., the pressure drop between the superheater outlet and the turbine throttle at full load to be 8 lb., and a pressure drop between the receiver tank and discharge chamber of 6 lb., the total of 23 lb. is the difference in pressure between the discharge chamber and the boiler drum. The elevation of the chamber above the boiler drum must be sufficient to produce a head equivalent to this pressure difference of 23 lb., and assuming a water temperature of 400 deg. F. the required height becomes 23×2.7, or 62 ft.

There are several evident features of this system that may make it impractical of installation in some plants. For example, it may not be possible to locate the receiver tank below the lowest point in the steam main to be drained and allow for sloping the collecting pipe to the receiver tank. Only steam lines carrying main steam pressure can be included in the system. The elevation of the discharge chamber may cause difficulty. It cannot be used to drain systems in which the pressure is less than 50 lb.

These difficulties are offset by the advantage of having a system free from mechanisms or any element requiring maintenance—a system which, once put in operation, may be forgotten.

What Do You Know?

RECENTLY, in commenting on the "Ask Me Another" craze, a prominent engineer expressed some curiosity as to what batting record the average engineer would show if the question were on engineering items. Here is your chance to prove yourself by answering the list of questions below. You will find answers on page 674 for a check on your accuracy. A list of questions will appear in each week's issue.

Ques. 1—What is an "old man?"

Ques. 2—When water pipes burst from freezing, at what temperature does the rupture occur?

Ques. 3—When a direct-current motor is used as a generator, what changes in connection are necessary?

Ques. 4—Will the capacity of an oil engine decrease if installed at a high altitude? If so, to what extent?

Ques. 5—Is it possible to have a stack too large in diameter?

Ques. 6—What is meant by a reaction steam turbine?

Ques. 7—What was the particular feature of valve gearing invented by George Corliss?

Ques. 8—What is the average gallonage of condensing water used per minute per ton of refrigeration in a refrigeration plant?

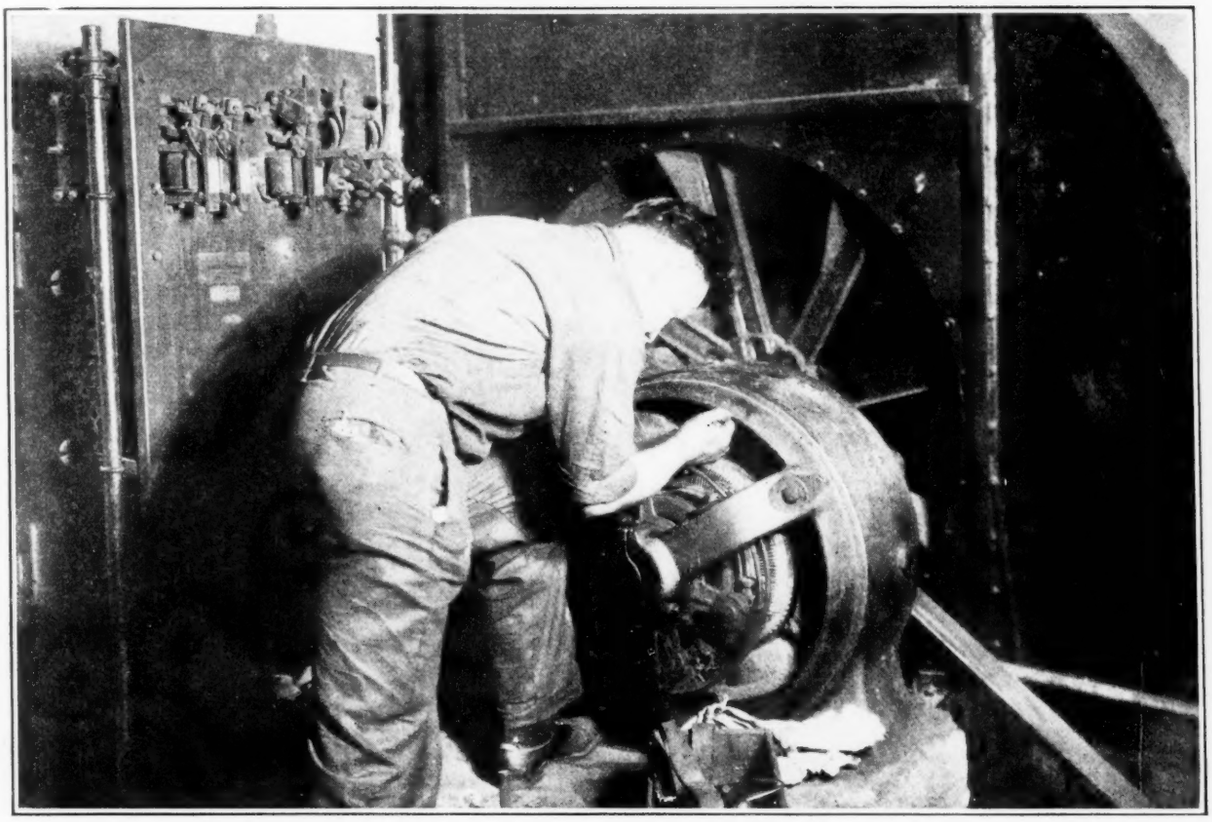
Ques. 9—What causes a gage glass to indicate a higher water level after the water column has been blown down?

Ques. 10—Who brought out a practical steam engine previous to the time of Watt?

Have you a pet question for stumping your friends? If so, send it in.

WHILE A SATURATED MIXTURE of gasoline vapor and air contains twice as much air as gasoline, by volume, the gasoline is 50 per cent heavier than the air. Such a mixture is too rich to explode and must be diluted with at least ten times as much air by volume as the saturated mixture contains before it becomes explosive.

A TYPOGRAPHICAL ERROR crept into the reference in last week's issue to *Power's Prize Contest*. The length of article should be around 4,000 words and not 40,000 words, as stated.



Locating Troubles in Direct-Current Machines

By C. O. MILLS

IMPROPERLY adjusted brushes, armature out of center of polar space, unequally spaced field poles, defective castings and other defects have been the cause of some baffling sparking at the brushes. This article shows the effects of these faults and explains how to remedy them.

PROPER alignment, spacing and location of the brushes on the commutator of direct-current machines are three essentials to good operation. Brushes may be out of line with the commutator owing to bent brush-holder studs, insulating washers being of unequal thickness, brush-holder yoke bent or not properly set, brush-holders set at different distances from the commutator, the commutator bars not in line with the shaft, or what is known as a twisted commutator. In the last-named case the trouble is not with the brush rigging, but in the commutator. To correct this difficulty, it will be necessary to reassemble the commutator and make the bars line up with the shaft.

The effect of the brushes being out of line with the commutator is to cause unequal spacing of the brushes and also results in the equivalent of increasing the thickness of the brushes. In Fig. 1 the brushes are shown in line with the commutator, and in this position they cover about two segments. With the brush-holder stud bent as in Fig. 2, the brushes span about $2\frac{3}{4}$ segments, which is the same as if brushes wide enough to cover $2\frac{3}{4}$ segments were used. In some cases this might not interfere with good commutation, but if brushes that cover two segments were about the limit of thickness, then the brushes on the bent stud would probably cause trouble.

Where the brushes make a considerable angle with the commutator, they may be thrown out of line with it, as shown in Fig. 3, by the distance the brushes extend through the brush-holders. If all the brushes extend the same distance through the holders, then they should line up with the commutator as in Fig. 4. On some brush-holders the studs are held to the yoke in slots, which allows adjusting the distance between the studs and the commutator. Where this can be done, the distance between the studs and commutator should be made the same on all before attempting to align the brushes with the commutator.

Unless the brushes make an approximate fit with the commutator when they are first adjusted, sandpapering them to a fit may take off enough to throw them out of

line. In such cases it will be necessary to make a second adjustment of the brushes and again fit them to the commutator before they will be in proper alignment.

While the brushes are being fitted to and aligned with the commutator, they should be checked for spacing around the commutator. This can be done by counting the number of segments and dividing this number by the number of poles, then space the brushes this number of bars apart. For example, assume that the commutator has 80 segments and there are 4 poles in the machine. Then the brush groups would be spaced 80 ÷ 4 = 20 segments apart.

How to Check the Spacing of Brushes

As a final check on the spacing, after the brushes are fitted, place a strip of paper around the commutator and mark on it the position of each group of brushes, as indicated in Fig. 5. If the brushes are equally spaced, the marks on the paper will be equal distances apart.

Unless the brushes are equally spaced around the commutator, it may be impossible to get all of them to operate without sparking. With unequal spacing, when certain brushes are on the neutral others will not be and may spark. Even though unequal spacing of the brushes does not cause serious sparking, it may result in circulating currents being set up between the different groups of brushes. These currents may overload the machine and cause excessive heating of the windings. It has been found by tests that these circulating currents may exceed the full-load current of the machine.

How circulating currents are caused to flow in the windings is shown in Figs. 6 and 7. Assuming the

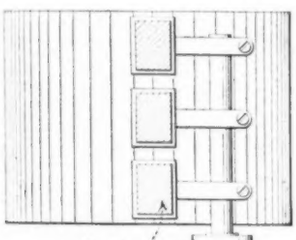


Fig. 1—Brushes in line with commutator

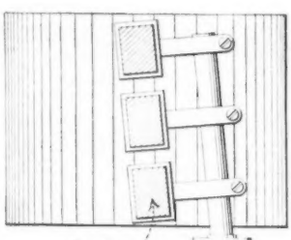


Fig. 2—Brushes out of line with commutator

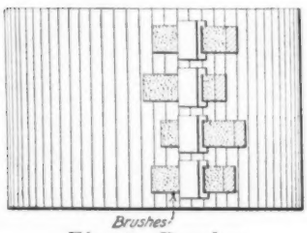


Fig. 3—Brushes not in line

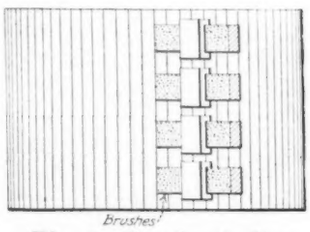


Fig. 4—Brushes in line with commutator

machine to be a generator rotating in a counterclockwise direction, it will have a voltage generated in the armature winding as indicated by the arrowheads. With the brushes equally spaced, the voltage between any two groups that are 90 deg. apart should be equal, as shown. In this case the armature is assumed to be generating 120 volts. From the direction of the arrowheads it is evident that the voltage in the section of the winding *ab* opposes that in section *ad*. This is also true for any other two adjacent sections, and since these voltages are equal, they neutralize each other and no current is circulated through the winding. This is just as it should be, as the only current flowing in the winding should be that delivered to the external circuit.

If one of the brushes is misplaced so that the winding is not equally divided, then the voltages between the brushes will not be balanced, and circulating currents

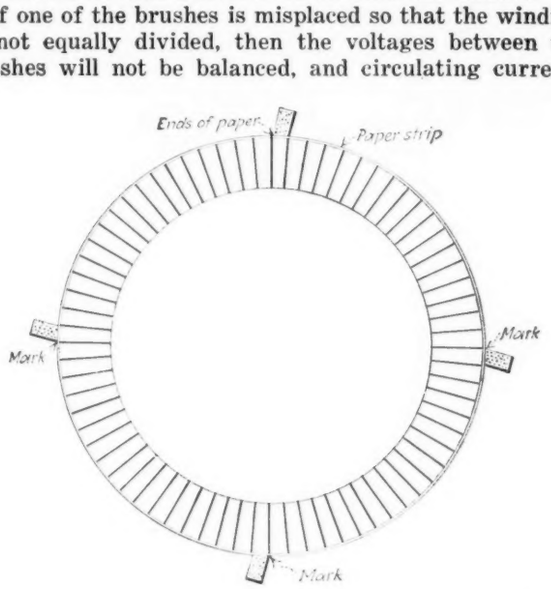


Fig. 5—Strip of paper used to check brush spacing

will flow. In Fig. 7, brush *B* has been shifted so that the section *ce* is added to section *dc*. Assume that there are two volts generated in section *ce*. This part of the winding has been taken from section *bc* and will reduce the voltage *be* to 120 — 2 = 118 volts. Section *ce* has been added to *dc*, but as the voltage in *ce* opposes that in *dc*, one is subtracted from the other, and the voltage *de* becomes 120 — 2 = 118 volts, as shown.

Voltages No Longer Equal

Under the foregoing conditions the voltages in the different sections of the winding between brushes are no longer equal. From *a* to *b* there are 120 volts that are effective from brush *A* through the jumper around to brush *B*, and are opposed by only 118 volts in section *bc*. Therefore, a current will flow through the winding from *e* to *a* and *A* to *B*, equal to 120 — 118 = 2 divided by the resistance of this circuit in ohms. As the resistance of this circuit is low, the current may be of considerable value even with two or three volts applied. In the section of winding *ad* there are 120 volts which are opposed by only 118 volts between *de*, so that a current can circulate from *A* to *B* and through the winding *eda* equal to two volts divided by the resistance of the circuit. From the foregoing, it is evident that if circulating currents in the armature winding are to be prevented, the brushes must be equally spaced around the commutator.

These circulating currents, although they limit the capacity of the machine by heating the winding, do not load the machine mechanically. The circulating current flowing in the section of the winding *abe* has the same direction under the *N* pole as it has under the *S* pole; consequently, the torque produced in the winding under the *N* pole will oppose that under the *S* pole, and the two torques neutralize each other. This is also true of the torque produced by the winding under the other two poles. The resultant torque due to the circulating cur-

rent, opposing the prime mover, is zero, and it will require practically no more power to drive the generator with circulating currents in the armature than without them. The circulating current is as effective in heating the winding as the load current, so that every ampere of circulating current in the winding is just that much less load the machine can supply without overheating.

Under normal conditions, with the assumed polarity of the field poles and direction of voltage in the armature, the polarity of the armature at brushes *A* and *B* would be *S*. With circulating current only flowing in the armature, the direction of the current at brush *B* is reversed; consequently, the polarity of the winding will be reversed. The effect of reversing the polarity of the armature at brush *B*, combined with this brush being off the neutral, may cause severe sparking at this brush.

With a load on the machine the current will be unbalanced in the armature winding. At full load as indicated by an ammeter in the external circuit, one-half of the winding may be heavily overloaded and the other half only partly loaded. Such a condition would result in overheating of the winding and probably severe sparking at some of the brushes, when, from the meter readings, the load indicated is well within safe limits.

On machines that have the polepieces cast into the frame, it is not uncommon to find them unequally spaced. Unequally spaced polepieces will have the same effect as unequal spacing between brush groups, but it cannot be corrected by changing the spacing of the brushes to match the spacing of the polepieces. The remedy is to try to trim the polepieces in such a way as to obtain symmetrical distribution of the magnetic field from the poles into the armature. A condition like this is something it will be well to refer to the manufacturers of the machine, as they should know better than anyone else how to go about remedying the defect, if a remedy is possible.

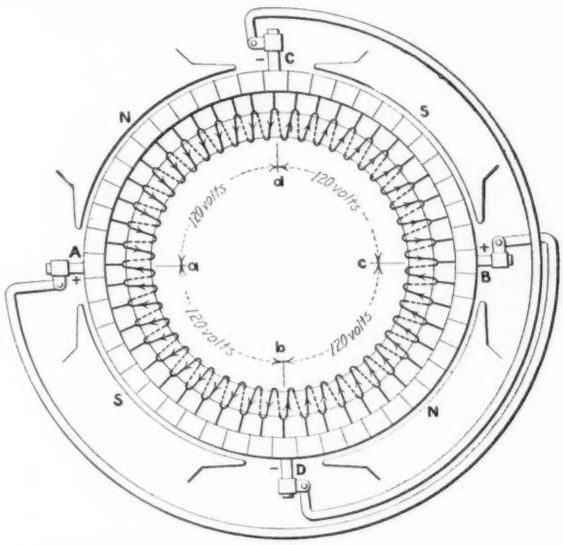


Fig. 6—Brushes equally spaced around the commutator, no circulating currents

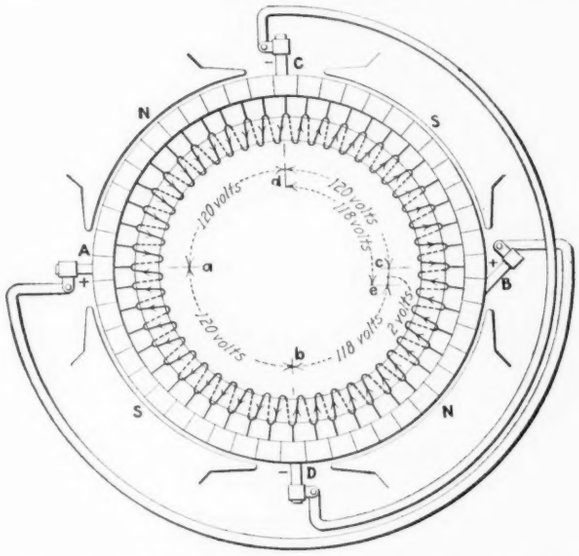


Fig. 7—Brush B off the neutral may cause circulating currents in the armature winding

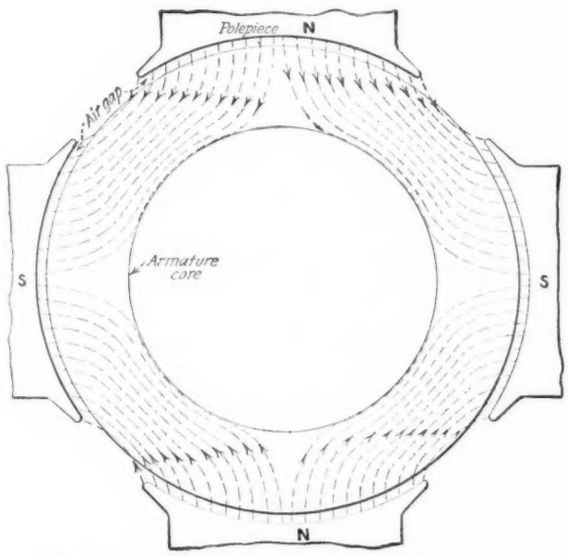


Fig. 8—Armature in center of polar space

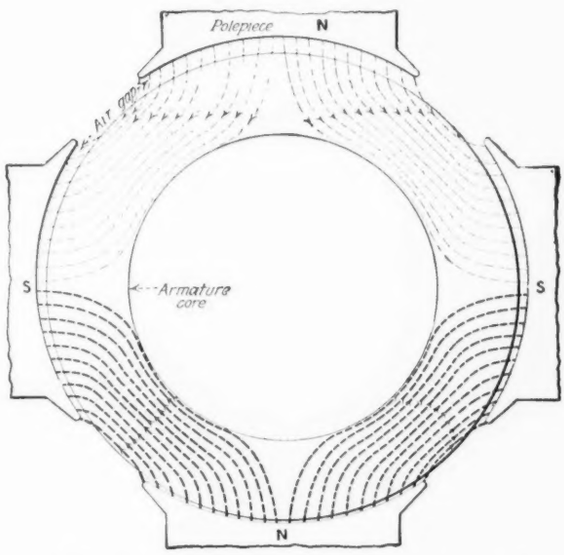


Fig. 9—Armature out of polar-space center

Another cause of circulating currents in the armature is an unequal air gap between the polepieces and the armature. In a four-pole machine the distribution of the magnetic field is as indicated in Fig. 8. If the armature is concentric with the field poles as in the figure, and other conditions are equal, then the flux density in the air gaps under all the poles should be the same. As the bearings wear, the lower air gap decreases, while the upper air gap increases, as in Fig. 9. The result of this is to increase the density of the field from the bottom *N* pole into the armature and decrease the field density from the top pole. This results in a decrease in the voltage generated in the section of the winding under the top pole and an increase in the voltage of the winding under the bottom *N* pole, and an unequal distribution of the current occurs in the armature winding.

Effect of Blowholes

A large blowhole in the field-frame of polepiece casting will cause unequal distribution of the field flux and unbalanced voltages in the armature winding. A number of small blowholes in one location in the field frame will have the same effect as a large hole. One of the difficulties in finding this kind of fault is that the blowholes cannot be located except with quite elaborate methods. However, circulating currents can be checked by connecting an ammeter into the jumpers between the brush groups, or the jumpers may be removed and voltage reading taken between the different groups of brushes. The readings obtained between positive and negative groups should be exactly equal. Readings taken with a low-reading voltmeter between brush groups of the same polarity should be zero. Unless these conditions are found, circulating currents will be set up in winding through the brush jumpers.

Where the field poles are held to the frame with bolts, unless the polepieces are all set an equal distance from the armature and all make equally good fit to the field frame, the magnetic fields from the different poles will not be of equal density. This will cause an unbalancing of the voltages in the armature winding and circulating currents. Where shims are used between the polepieces and frame, they should all be of the same size and of the proper thickness and made of the same kind of material, soft sheet iron or steel with the surfaces cleared of all oxide. The holding bolts should be free, so that the polepieces can be pulled tight to the frame without the bolts binding in the holes.

Effect of Circulating Currents Due to Improper Brush Spacing

The value of the circulating currents, due to improper brush spacing, the armature being out of center with the polepieces, or blowholes in casting, individually, are not likely to cause serious difficulties. But if two or more of these are combined in one machine so that their effects are cumulative, they may create conditions that interfere with the satisfactory operation of the machine. In cases of chronic trouble it is well to run down every possibility until the cause is found.

A short-circuit in a shunt-field coil or series-field coils of the wrong polarity may cause unbalanced voltages in the armature, and circulating currents; or, when the machine is loaded, unbalance of the current in the different sections of the armature. Therefore, in case of brush trouble, these windings should be checked carefully.

What has been said regarding circulating currents applies to armatures with lap windings, in which there are as many circuits as poles. Where the winding is connected wave—that is, two-circuit—the voltages tend to balance out in the two paths and circulating currents are prevented.

Unequal Division of Current in Brushes

The condition of the brushes and the way they fit the commutator may cause the current to divide unequally in the different sections of the winding. Brushes of different grades may have a considerably different resistance, due not only to the composition of the brush materials, but also to the resistance of the contact that the brush makes with the commutator. The size and the method of connecting the shunts to brushes may also affect the resistance of the current path from the commutator to the brush-holders. Therefore, if equal distribution of current is to be expected between the different groups of brushes, then all brushes must be of the same grade, equipped with the same kind of shunts and properly fitted to the commutator. A brush that fits to the commutator over its whole surface will be a better conductor than one that fits on only one-half its surface or less.

What is true of brush groups applies to the individual brushes in each group. Unless all brushes are alike, the current will not divide equally among them. This may cause sparking and heating of some brushes while others in the same groups are apparently satisfactory in operation.

Equal distribution of the current among the brush groups is essential to good commutation. On an interpole machine, the interpoles are adjusted for a given relation between the interpoles and the armature-pole strengths. As long as the current divides equally between the brush groups this relation can be maintained. With the current unbalanced between the brush groups the armature field poles will have different values. Since the interpoles are in series, they will tend to have equal strength, and the relation between the interpoles and armature will be disturbed and sparking at the brushes is likely to result.

Figuring Jet Velocity

When a fluid is throttled through a valve or orifice, under conditions of continuous steady flow, the fluid flows through the restricted opening at high velocity, which can be computed from the "heat drop." For vapors this is most easily done with the aid of the Mollier or some similar diagram. The heat content and entropy are noted for the initial conditions, and then the heat content is found corresponding to the final pressure but with the entropy the same as at the initial conditions. The difference between these two heat contents is the energy theoretically available to be converted into kinetic energy of the jet.

The calculation is made in three steps: (1) Convert the difference between the heat content values, in B.t.u., into ft.-lb. by multiplying by 778; (2) multiply this by 64.4; (3) take the square root. This gives the *theoretical* jet velocity, in feet per second. If the restricted opening is a smooth orifice or a properly formed nozzle, such as is used in a steam turbine, the actual velocity will be only a little less than this calculated value. The further the restriction departs from this ideal smooth type, the lower will be the jet velocity.

Safe Loading of Cables, Chains and Eyebolts

By N. L. REA,
Contract Service Department, General Electric Company

WHEN machinery parts are lifted, account must be taken of the increased stresses in the individual slings when a load is lifted by two or more slings connected to the crane hook and making an angle with each other, as in Figs. 3 and 4. On account of the angle between the two sets of ropes the stress on each set is greater than half the total load, increasing rapidly as the angle between the sling and the work is decreased. An angle of 45 deg. between the sling and the work, as in Fig. 3, makes the stress in each sling nearly three-fourths of the total weight being lifted.

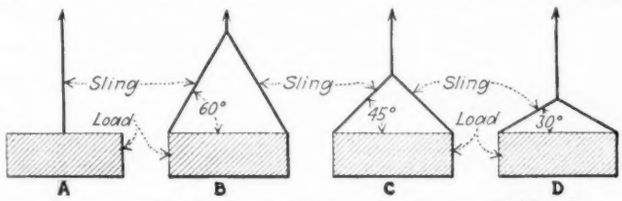


Fig. 1—Method of lifting loads in Table I

TABLE I—SAFE LOADS FOR ROPES AND CHAINS, IN POUNDS[1]

Material	Dia., In.	When Used Straight, As in Fig. 1A	When Used at 60 Deg. Angle As in Fig. 1B	When Used at 45 Deg. Angle As in Fig. 1C	When Used at 30 Deg. Angle As in Fig. 1D
Plow-Steel Wire Rope (6 strands of 19 or 37 wires.) If crucible steel rope is used, reduce loads one-fifth.	⅜	1,500	1,275	1,050	750
	½	2,400	2,050	1,700	1,200
	⅝	4,000	3,400	2,800	2,000
	¾	6,000	5,100	4,200	3,000
	⅞	8,000	6,800	5,600	4,000
	1	10,000	8,500	7,000	5,000
	1¼	13,000	11,000	9,000	6,500
	1⅜	16,000	13,500	11,000	8,000
	1½	19,000	16,000	13,000	9,500
	1¾	22,000	19,000	16,000	11,000
	Dia. of Iron, In.				
Crane Chain (Best grade of wrought iron, hand-made, tested, short-link chain.)	½	600	500	425	300
	⅝	1,200	1,025	850	600
	¾	2,400	2,050	1,700	1,200
	⅞	4,000	3,400	2,800	2,000
	1	5,500	4,700	3,900	2,750
	1⅛	7,500	6,400	5,200	3,700
	1¼	9,500	8,000	6,600	4,700
	1⅜	12,000	10,200	8,400	6,000
	1½	15,000	12,750	10,500	7,500
	1¾	22,000	19,000	16,000	11,000
	Dia., In.	Cir., In.			
Manila Rope (Best long fiber grade.)	½	1	120	100	85	60
	⅝	1½	250	210	175	125
	¾	2	360	300	250	180
	⅞	2½	520	440	360	260
	1	2¾	620	520	420	300
	1¼	3	750	625	525	375
	1½	3½	1,000	850	700	500
	1¾	3¾	1,200	1,025	850	600
	1½	4½	1,600	1,350	1,100	800
	1¾	5½	2,100	1,800	1,500	1,050
	2	6	2,800	2,400	2,000	1,400
	2½	7½	4,000	3,400	2,800	2,000
	3	9	6,000	5,100	4,200	3,000

[1]Prepared by National Founders' Association.
Caution: When handling molten metal, wire ropes and chains should be 25 per cent stronger than indicated in table.
Note.—The safe loads in table are for each single rope or chain. When used double or in other multiples the loads may be increased proportionately.

A collapsing force equal to one-half the load being lifted is also set up between the two points of attachment. If the work is ring-shaped, as in Figs. 3 and 4, this force tends to deform the ring. A spreader of sufficient stiffness should be used between the two points of attachment to resist this collapsing force. It will be seen that eyebolts are not suitable for attaching the slings to the work unless a spreader is used to relieve them of this side pull which would put a heavy bending moment on the shank of the bolt. Reducing the angle between the sling and the work to 30 deg., as in Fig. 4, makes the stress in each sling equal to the total weight, and the collapsing force equal to 0.87 of this weight. Such a small angle should never be used if avoidable.

For a triple sling connecting to the work at three points 120 deg. apart, an angle of 45 deg. between sling and work gives a stress in each sling equal to nearly one-half the total weight and a collapsing force of one-third the total weight. For an angle of 20 deg. (which should never be used if avoidable) these forces are approximately equal to the total weight.

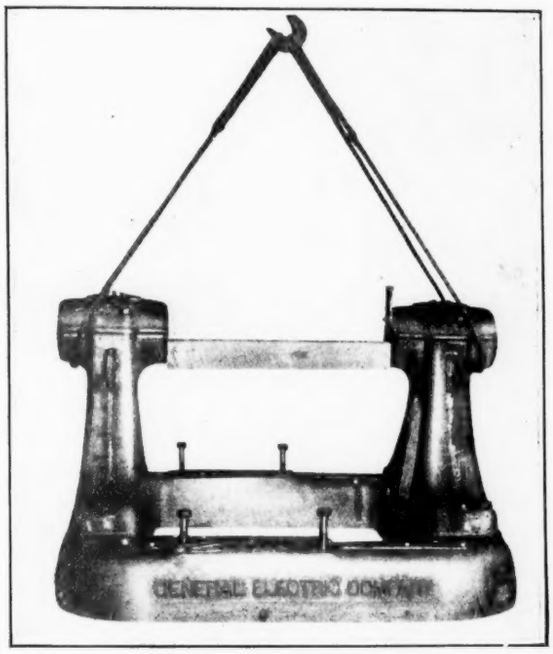


Fig. 2—Proper method of lifting a machine frame by the bearing pedestals

For a quadruple sling connected to the work at four equidistant points, the stress in each sling may be one-half that in each half of a double sling for the same angle between sling and work, but in all such multiple slings due allowance must be made for the fact that they cannot all be pulled up equally tight, and the several slings will not share the load equally. For this reason three slings are generally preferable to four. Table I, prepared by the National Founders Association, gives the safe load for ropes and chains. In the fourth column values are given for when the slings make an

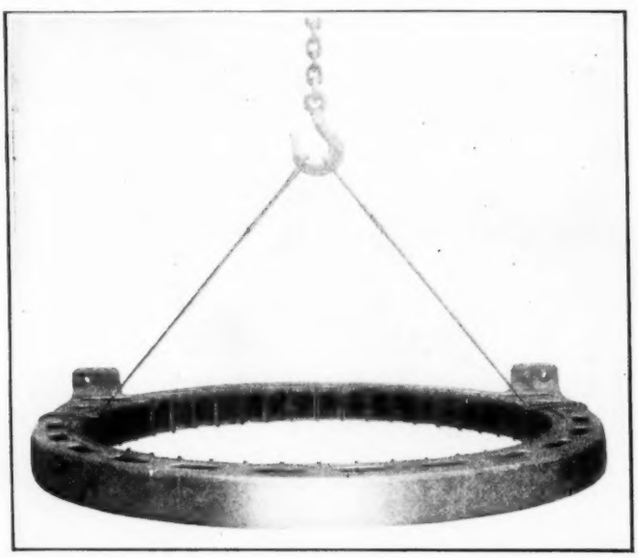
angle of 30 deg. with the load, as indicated in Fig. 3*D*. These values are only one-half those given in column one, when the slings are used straight, as in Fig. 3*A*. In other words, two slings connected as in Fig. 3*D* are good only for a load that can be lifted by one similar sling used straight, as in Fig. 3*A*.

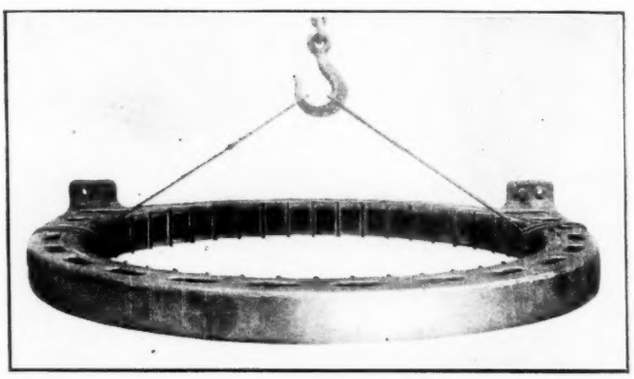
The bases of rotary converters, generators and motor-generator sets are often shipped with the bearing pedestals bolted in place and the base blocked directly on the car or mounted on a skid. The natural way of lifting them is to put the slings under the outside ends of the bearing housings. The slings will have considerable angle and consequent side pull, and there is a leverage due to the height of the pedestals above the base.

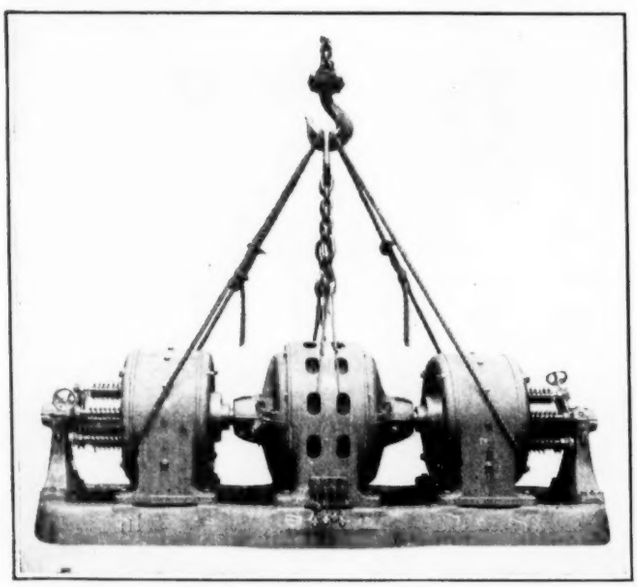
The effects of these factors are likely to break the base or pedestals or at least distort them badly. A heavy brace should always be fitted between the ends of the bearing housings, as shown in Fig. 2. This brace should be large enough and fitted tightly between the bearing housing and have a good bearing on the end of the housings. A light, poorly fitted stick may be the cause of breaking a piece out of the housing.

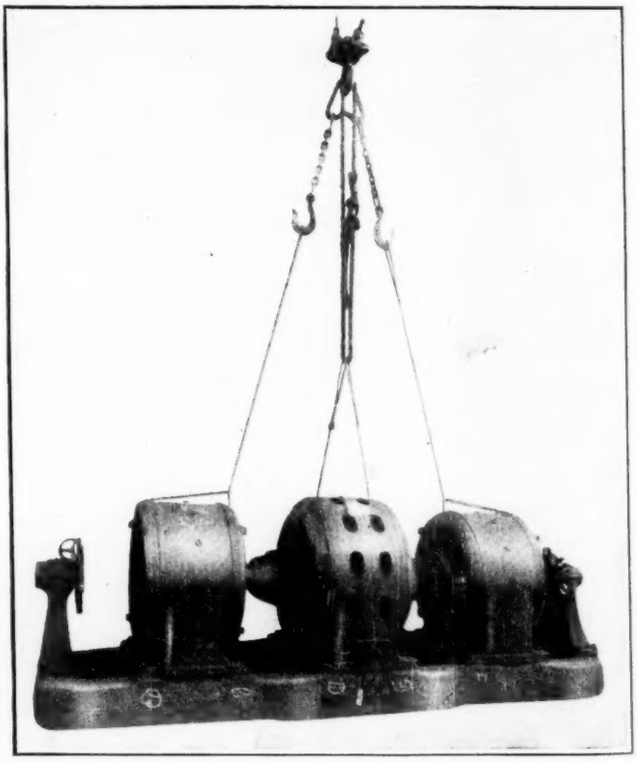
Many motor-generator sets are shipped partly or completely assembled to save time and money in boxing and erecting. A set of any size and weight must be handled carefully to prevent damage. Fig. 5 shows a good way of handling this class of equipment. The hitch on the motor is made with steel slings, and manila rope is used on the two generators. The manila slings have an eye in one end so that their length can be readily adjusted to divide the load among all three. A sheet bend works nicely with the eye in the end of the ropes. The wrong way of handling this equipment is shown in Fig. 6. The manila rope has a sharp bend where it passes through the loop of the wire cables. There are many unprotected sharp corners where the wire cable will be damaged, and the manner of attaching the slings to the end machines prevents an even distribution of the load.

Using chains for lifting is an entirely different problem from that encountered with either hemp rope or









Figs. 3 to 6—Correct and wrong way of lifting machines by two or more slings.

Fig. 3 (top left)—Two slings making an angle of 45 deg. with the load. Fig. 4 (top right)—Two slings making an angle of 30 deg. with the load. Fig. 5 (lower left)—Proper method of lifting a motor-generator set. Fig. 6 (lower right)—wrong method of lifting a motor generator set, as it is impossible to get proper load distribution between the slings.

wire cable. Chains, outside of a few bruises or bent links, give no indication of their condition. The links may be full of cracks too small to be seen with the naked eye or they may be badly crystallized from long use. Under these conditions the chains grow rapidly weaker with every lift and may fail at a fraction of the rated load.

A rough estimate can be made of the weight of various pieces of machinery by use of Table II. Some old riggers can make uncannily close estimates offhand.

All that is necessary to find the weight of any piece of shafting, knowing the weight per foot, is to multiply the weight by the number of feet in length, which will give the net result in pounds to be lifted. For instance, a piece of shafting 16 in. in diameter, 1 ft. long, weighs 676 lb. A piece of shafting of this same diameter and 16 ft. would weigh $16 \times 676 = 10{,}816$ lb. Provision in this case should be made for lifting at least six tons.

TABLE II—WEIGHTS OF VARIOUS MATERIALS

Material	Weight per Cu.Ft. in Lb.	Weight per Cu.In. in Lb.
Cast iron	450	0.26
Steel	489	0.28
Copper	552	0.32
Lead	709	0.41
Ash	45	....
Pine	38	....
Concrete	155	....
Stone	180	....
Earth	72 to 110	....
Brick	100 to 150	....
Mortar	100	....
Marble	180	....

Shafts

Diameter, In.	Weight of Shafting, Lb. per Lin.Ft.
6	95
8	169
10	264
12	368
14	517
16	676

All irregular-shaped castings and, in fact, all castings weighing over a ton, should have the gross weight

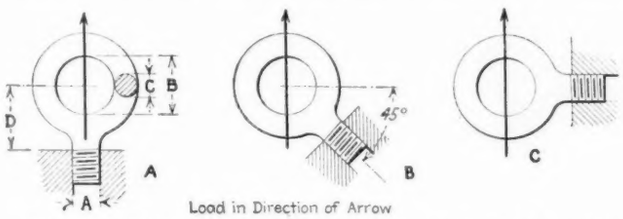


Fig. 7—Direction of loading eyebolts, Table III

TABLE III—SAFE LOAD IN POUNDS ON EYEBOLTS, FIG. 7

Dimensions in Inches, Fig. 7A				Loaded As in Fig. 7		
A	*B*	*C*	*D*	7A	7B	7C
			Drop-Forged Steel			
1	1 1/8	7/16	1 1/2	1,100	50	40
1 1/16	1 1/16	1/2	1 5/8	1,500	70	50
1 1/16	1 11/16	5/8	1 3/4	1,800	90	65
1 1/16	1 13/16	3/4	2	2,800	135	100
1 1/16	1 15/16	13/16	2 1/8	3,900	210	150
1	2 1/16	15/16	2 1/4	5,100	280	210
1 1/4	2 5/16	1 3/16	2 7/8	8,400	500	370
1 1/2	2 1/16	1 3/8	3 1/4	12,200	770	575
1 3/4	3 1/16	1 1/2	3 5/8	16,500	1,080	800
2	3 1/16	1 5/8	3 7/8	21,800	1,440	1,140
			Welded Wrought Iron			
1 1/2	3	1 1/2	3 1/4	10,000	800	600
1 3/4	4	1 3/4	4	11,000	660	485
2	5	1 3/4	4 1/2	14,000	885	655
2 1/4	6	2	5 3/4	16,000	1,050	770

marked in plain figures. It is always safer to overestimate a weight than to underestimate it; and it is always safer to use slings of ample lifting capacity than those about which one is in doubt.

Eyebolts have been the cause of many accidents because of improper use by thoughtless or ignorant men, so their use deserves special consideration. Most failures come from using them to take load at an angle.

In general they should fit fairly snug in the tapped hole and the strain must be in a straight line with the threaded shank. If there is any question about condition, don't use them. Eyebolts for miscellaneous work should not be painted, as the paint may fill or cover cracks or flaws. They should be tested occasionally and

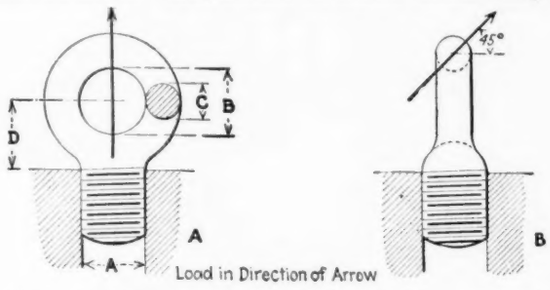


Fig. 8—Direction of loading eyebolts, Table IV

TABLE IV—SAFE LOADS IN POUNDS ON EYEBOLTS, FIG. 8

*Size in In.	Threads per In.	Dimensions in In., Fig. 8.1 *A*	*B*	*C*	*D*	Safe Load in Lb. Fig. 8.1	Fig. 8*B*
1 1/4	7	1 1/4	1 1/2	5/8	1 3/8	1,500	600
1 1/2	6	1 1/2	1 3/4	11/16	1 5/8	2,500	800
2	4 1/2	2	2 1/4	1	2 1/4	4,000	1,500
2 1/2	4	2 1/2	2 3/4	1 1/4	2 1/2	5,500	2,600
3	3 1/2	3	3 1/4	1 1/2	3 1/4	9,000	3,600
3 1/2	3 1/4	3 1/2	4	1 3/4	4	14,000	4,800

*These sizes should be used in place of commercial eyebolt sizes: 3/4, 1, 1 1/4, 1 1/2 and 2 in. respectively.

always when being used for anything near their rated strength. Screw the eyebolt snugly in the hole and tap it smartly with a light hammer. The blow should not be heavy enough to bend the bolt, but just a light quick tap. If the bolt doesn't "ring clear," one of two things is wrong—the bolt is too loose in the hole or it is cracked. Tap it again with the finger tips held against the junction of the work and the bolt; if there is any appreciable movement or the bolt doesn't feel solid, *be careful*. It is better to get another bolt or use some other way of making the lift.

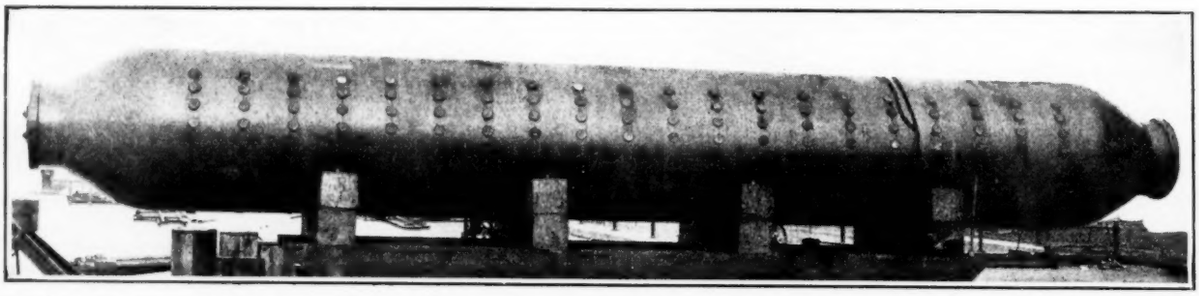
Table III gives average figures on drop-forged steel and welded iron of the standard types of eyebolts. Special notes should be made of the tremendous decrease in safe loading when the lift is made at an angle to the axis of the threaded portion. The strains set up in an eyebolt when used at an angle are very severe, owing to the bending action on the bolt, and it may break where it screws into the work. This is clearly shown in the table, which gives the safe load when used for a direct pull and also shows how the strength of the bolt rapidly decreases according to the angle that may be used. For example, a 1-in. eyebolt on a straight lift, Fig. 7A, is good for a load of 5,100 lb. When used at an angle of 45 deg., as in Fig. 7B, the safe load on a 1-in. eyebolt is reduced to 280 lb. and when used in a right-angle lift, the safe load is 210 lb.

The eyebolts shown in Table IV were designed to overcome this handicap as much as possible, but even with these there is a great falling off in strength when they are subjected to a side pull. A heavy spreader can sometimes be used to advantage when lifting a flat piece with two or more eyebolts. But it is never safe to suspend a revolving field by an eyebolt screwed in the end of the shaft, although the eye may be strong enough to lift the weight once it is turned up so the pull comes in a straight line.

The design and construction of
Pressure Vessels—II

Modern Practice in Seamless and Welded Construction

By LEWIS J. SFORZINI



Forged seamless steel drum for 1,200-lb. boiler in the Edgar station of the Edison Electric Illuminating Company of Boston

NOTHING is more important to the power-plant engineer than an understanding of the principles underlying the design and construction of pressure vessels. This is the second of two articles in which the whole subject is outlined in a broad way. The first installment, which appeared in the previous issue, gave the principal formulas applicable to all types of construction and then discussed cast-iron and riveted vessels. The present article shows how seamless and welded pressure vessels are fabricated.

THIS article concludes the outline of pressure-vessel engineering which was started in the preceding issue. That installment covered certain fundamentals that apply to all pressure vessels, however constructed, and went into some detail as to use of castings and riveted joints. The present article discusses certain other methods of fabrication with which every engineer should be familiar. Fig. 1 shows a boiler drum used for 1,200 lb. per sq.in. working pressure. It was forged from a solid ingot of steel weighing 131 tons, over a mandrel in a manner similar to that used in forging guns of large bore. The thickness of this drum is 4 in. and the over-all length, 32 ft. Anticipating a growth in the use of forging for the manufacture of boiler drums, the A.S.M.E. has recently issued a tentative addenda to the Boiler Code (see *Power*, Dec. 1, 1926), covering this type of construction. The Code, in addition to specifying certain chemical and physical limitations, sets the ultimate tensile strength of what is termed class I steel at 60,000 lb. per sq.in. minimum, and Class II steel at 75,000 lb. minimum. Using a factor of safety of 5, this permits of working stresses of 12,000 and 15,000 lb. per sq.in. respectively.

As an example, consider two drums of 42-in. inside diameter, each made of 1-in. plate. One is fabricated from plate of 55,000 lb. minimum tensile strength, with quadruple-riveted double-strap butt joint of 90 per cent efficiency. The other is forged from class I plate of 60,000 lb. minimum tensile strength. Using a factor of safety of 5 in. in both cases, the safe working pressure is[1]:

$$P = \frac{2 \times 11{,}000 \times 0.90}{42} = 471 \text{ lb. per sq.in. for riveting}$$

$$P = \frac{2 \times 12{,}000 \times 100}{42} = 571 \text{ lb. per sq.in. for forging}$$

This shows that even for comparatively thin shells forging from the solid permits over 20 per cent more pressure than an elaborately riveted joint. Although at the present writing, forged-from-the-billet drums cost considerably more than riveted drums of equal strength, improvements due to increased production might reduce the price differential. Of course, where practical limitations in extremely thick shells prohibit the use of riveting, the forged drum would be used in spite of the cost.

The forging process just mentioned employs a solid cast ingot which is first either bored or pierced while hot and then forged over a mandrel to the desired thickness and length, after which the ends are formed to the desired shape.

Another seamless-shell process also employs a billet which is pierced, and, in this case, is then rolled over successive mandrels and between rolls in a heated condition until a tube of desired thickness, diameter and length is produced. A tube produced in this manner is known as a "hot-finished tube." Sometimes a tube produced as described is further worked cold through dies and mandrels to a desired diameter and thickness, and

[1] See first article for discussion of formulas for pressure vessel joints. Here the simple tank formula is used.

is known as "a cold-finished tube." This is one of the commercial processes for making seamless tubing from the smallest sizes to about 9-in. diameter. Cold-drawn tubes are annealed before using.

Still another seamless process employs a hot disk which is pressed into a cup shape while at a high temperature and is then forced by a plunger, while still maintained at a high temperature by continuously reheating, through successive dies until the desired diameter is obtained. The original end may be left on the tube and forged to any desired shape, or it may be cut off. This is another of the commercial processes for making seamless tubing, and is used for sizes from about 6-in. to 20-in. diameter.

The machinery and processes for making seamless tubing are very elaborately developed, so that seamless shells for pressure vessels may be obtained at reasonable cost. Heads or ends for making a pressure vessel out of a seamless tube will be described presently.

Two distinct welding processes may be employed for producing shells. The first process, working on a plate which is entirely heated in a furnace of proper type, is used in making commercial tubes and pipes from ⅛-in. diameter in the smallest size to about 30-in. diameter in the largest size. The second process confines the heating to the vicinity of the weld, and is used in making shells from about 12-in. diameter to practically any diameter, say up to 96 in. or over.

Fig. 1 (a) shows a plate ready for welding. It was placed in this condition from a sheet by either hot bending through a die, or hot rolling through. The rough

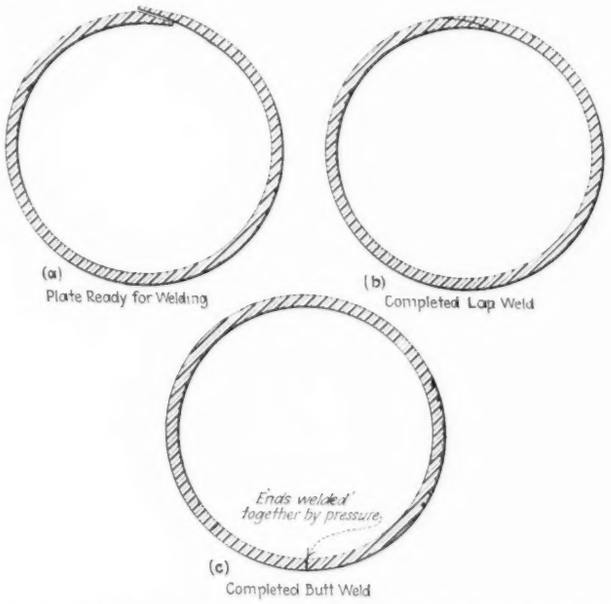


Fig. 1—Shells or tubes made from plates entirely heated

tube is now reheated to a proper temperature and passed over a mandrel between two rolls, pressing the two edges together to form a complete weld as in Fig. 2(b).

The pipe is further rolled and worked to correct irregularities, and is then allowed to cool slowly. The resulting tube is what is commercially known as lap-welded pipe, and is made in sizes from about 1½ in. up to 30 in. diameter.

Welded tubes smaller than 1½-in. diameter are made by the butt-weld process. The completely heated flat plate at proper temperature is drawn through funnel-shaped dies, gradually forcing the plate to a circular cross-section, pressing the ends together and welding them.

After welding, the tube is rolled on sizing and finishing rolls and then allowed to cool gradually. The complete weld is as shown at Fig. 1 (c) and is prac-

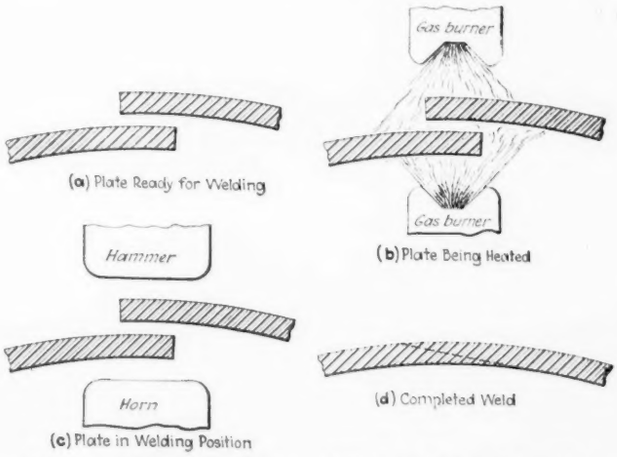


Fig. 2—Stages in forge welding with local heating

tically invisible. Butt-weld pipe is made from ⅛-in. size to about 3-in. This class of tubing has no great application for pressure vessels, but is here given for completeness.

Welding of shells from a plate locally heated is a comparatively new development in the pressure vessel field. There seems to be no agreement among the manufacturers of this class of material as to name. The process is variously called forge welding, fire welding, hammer welding and lap welding.

A flat plate of the proper width, thickness and length is rolled cold through ordinary plate rolls so that the edges overlap as in (a), Fig. 2. Heat usually from water-gas burners, is applied to both overlapping edges, as in (b). When the proper welding heat is reached, the plates are welded between a hammer and horn (c). The process of heating and welding is repeated until the entire seam is welded.

After welding, the shell is again rolled to correct any unevenness and is then annealed by heating the complete shell to the proper temperature, and allowed to cool in air. If the facilities are not available for complete heating, the strains in the vicinity of the weld may be removed by heating near the weld and cooling slowly in air.

There are now manufacturers equipped to furnish locally welded shells of any diameter from about 12 in. up to 96 in. or more, and of any plate thickness up to 2 in. Lengths of shells in certain sizes may be up to 40 ft. If desired, shells may be procured with integral forged heads and forged outlets, or for fusion-welded heads and outlets.

Locally welded vessels fulfill the requirements of the Boiler Code and of the Pressure Vessels Code and may be used for all purposes where riveted construction is permitted.

Seamless tubes are as strong as the original plate or billet, so that if the minimum specified tensile strength is 45,000 lb. per sq.in., and a factor of 5 is used, the safe working stress becomes 9,000 lb. per square inch.

A welded pipe has a seam efficiency of between 85 and 95 per cent. If welded shells are made from plate of

45,000 lb. per sq.in. minimum tensile strength with a factor of safety of 5, and an efficiency of 85 per cent it results in a safe working stress of 7,650 lb. per sq.in. These values should be used in computing vessels from the formulas given in the first article.

Fig. 3 shows various forged or welded heads used in seamless tubes and welded shells. The flat heads of *(f)* and *(g)* may be used as tube sheets, in which case the rolled tubes are computed as a reinforcement for the flat heads.

Fig. 4 shows a locally welded shell 30 in. in diameter made of $\frac{7}{16}$-in. plate. The heads are welded to the shells. This vessel is designed for 300 lb. working pressure of ammonia.

Note the numerous openings, all of which are fusion welded to the shells. The openings shown are all welded in a manner not approved by the Pressure Vessels Code. They are shown in this manner to bring out certain features of the Code which are not acceptable to a large group of engineers. The 12-in. opening is made of ordinary pipe material. The flange is of cast iron and violates the Code in two particulars: It has not the curve or flare at the point of joining the shells, and it is welded with a fillet weld instead of a butt weld, as called for in sizes over 8 in.

The 6-in. connection violates the Code because the pipe is required to run through the plate in a neat fit and be welded inside and outside. The small openings are not in accordance with the Code because the ends are not either double welded, flared or screwed into the shell in addition to being welded as shown. But the welds shown have all been in use for fifteen or more

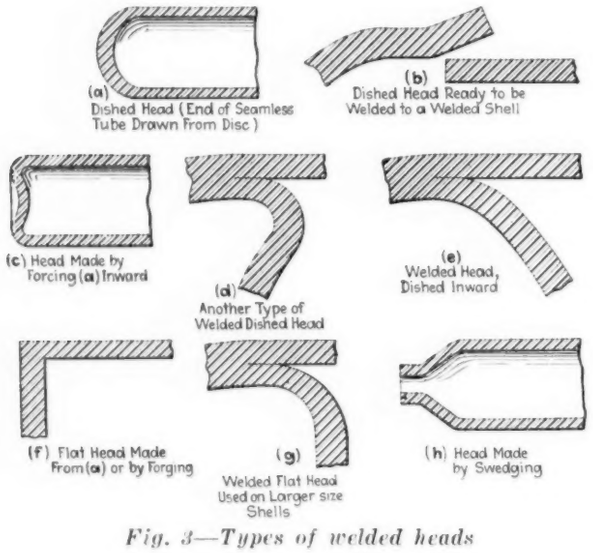

(a)
Dished Head (End of Seamless Tube Drawn From Disc)
(b)
Dished Head Ready to be Welded to a Welded Shell
(c) Head Made by Forcing (a) Inward
(d)
Another Type of Welded Dished Head
(e)
Welded Head, Dished Inward
(f) Flat Head Made From (a) or by Forging
(g)
Welded Flat Head Used on Larger size Shells
(h) Head Made by Swedging

Fig. 3—Types of welded heads

years on ammonia pressure vessels in sizes up to 12 in., and the writer has yet to hear of a case of outlet failure.

Were the Code accepted on this point, practically all fusion-welded steam-pipe headers figured as vessels would be barred, because, for instance, the welding of an 8-in., 10-in. and 12-in. outlet to a 12-in. header is prohibited, whereas this practice is very common.

The writer agrees with a great number of engineers, that the provisions in the Pressure Vessel Code should be revised to permit the welding of pipe outlets in the manner shown, in the interests of economy of manufacture, and because experience over a long period of years has shown this construction to be safe, whereas the writer doubts if the methods called for in the Code have been so tested.

Welded shells give very good results in all ammonia and other fluid work that calls for a greater tightness than riveted work and calking. One large manufacturer now makes practically every ammonia shell by

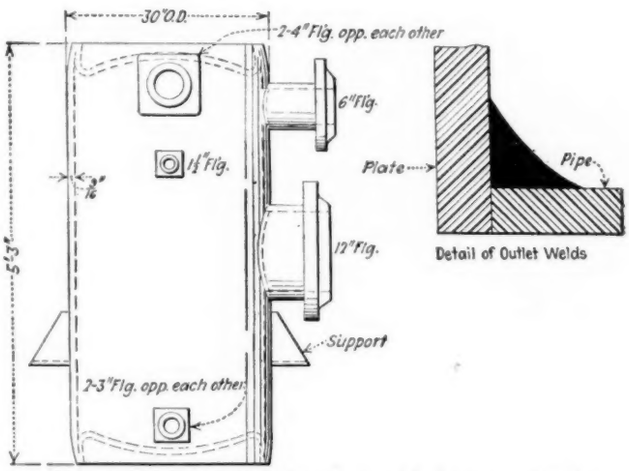


Fig. 4—Vessel with locally welded seam, heads and connections

local welding with excellent results. Receivers, accumulators, intercoolers, open heat exchangers, open condensers are completely welded. Closed shells such as brine coolers, intercoolers, condensers and heat exchangers have the tube sheets fusion welded to the welded shells.

A shell locally welded in accordance with the Pressure Vessels Code, 72 in. diameter, 20 ft. long, and for 125 lb. working pressure as an air receiver would have (using a factor of safety of 5, a joint efficiency of 85 per cent, and plate of 45,000 lb. minimum tensile strength) a thickness of:

$$t = \frac{125 \times 72}{2 \times 7650} = \frac{19}{32} \text{ in.}$$

This thickness is $\frac{1}{4}$ in. greater than that of the similar riveted shell of Fig. 3 (previous article). When the butt straps are considered, the riveted shell weighs about 800 lb., or ten per cent less than the welded shell. To make the welded shell as cheap as the riveted one there must be a saving in cost of welded seam over riveting and calking the seams to make up for this extra weight plus the mill extra for the single sheet.

Two processes of fusion welding may be employed in the manufacture of pressure vessels—gas welding and electric-arc welding. Electric-arc welding may employ either the metallic arc or the carbon arc.

With fusion welding, plates from the lightest gage to a thickness of 2 in. or more may be and have been welded together successfully as pressure vessels. At this point it may be well to point out that the fusion welding of power steam boilers is prohibited by the laws of certain states, certain municipalities and the A.S.M.E. Boiler Code, except where the stresses are carried by some other forms of approved construction.

The Pressure Vessels Code allows the use of fusion welding on circumferential seams of vessels where the diameter is 48 in. and under, and up to 72 in., when

75 per cent or more of the load on a flat head is stayed; it also permits the fusion welding of longitudinal steams on air vessels under 20 in. diameter, and under certain length limitations and where the working pressure does not exceed 100 lb. per square inch.

The Pressure Vessels Code imposes the further limi-

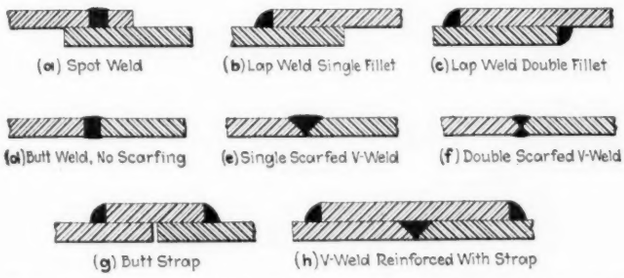

(a) Spot Weld
(b) Lap Weld Single Fillet
(c) Lap Weld Double Fillet
(d) Butt Weld, No Scarfing
(e) Single Scarfed V-Weld
(f) Double Scarfed V-Weld
(g) Butt Strap
(h) V-Weld Reinforced With Strap

Fig. 5—Some common welds used on longitudinal, girth and head seams

Fig. 6—Three additional girth or head welds

tation of $\frac{5}{8}$-in. base metal as the heaviest to be welded, and limits the safe working stress to 5,600 lb. per square inch. For a factor of safety of 5 this is equivalent to a joint efficiency only 62 per cent the strength of the original plate of 45,000 lb. ultimate strength.

While at the present time but few question the restrictions placed on fusion welding in the Boiler Code proper, a large group of engineers are advocating a revision in the Pressure Vessels Code in regard to pressure, thickness, diameter and length limitations as well as an increase to 8,000 lb. per sq.in. as the safe tensile strength, provided the fusion welds be of certain approved types.

In connection with a possible revision of these rules in the Pressure Vessels Code, there are soon to be inaugurated an extensive series of experiments on fusion-welded pressure vessels by the American Bureau of Welding in conjunction with the A.S.M.E. Until the results of these tests become available, the readers of *Power* are urged to keep an open mind on the subject of fusion welding.

To those engineers who wish to abide by the letter of the Pressure Vessels Code, the writer would point out that it is his experience that the bulk of pressure vessels are for working pressures under 30 lb. per sq.in., which the code does not affect. Another large class of vessels can be made with forge-welded longitudinal seams and fusion-welded head seams at but little increase in cost over all-fusion-welded vessels. Shell and tube apparatus under 72 in. can also be made with welded longitudinal seams and fusion-welded head seams.

Some of the various styles of joints that may be used in fusion-welded vessels on longitudinal seams, girth seams and head seams are shown in Fig. 5. The use of joint *(a)* is not advised except for the very lightest service. Joint *(e)* is a very good weld for head seams, but not so desirable for longitudinal welds. The use of joint *(d)* should be confined to plates under $\frac{1}{4}$ in. in thickness. Joint *(e)* is a single scarfed V-weld which should be used for plate thicknesses $\frac{1}{4}$ in. and over and in cases where it is impossible to weld both sides. Joint *(f)* is a double scarfed V-weld and may be used in plates from $\frac{1}{4}$ in. to 2 in. in thickness; this is the highest class of weld and insures thorough penetration. The head or girth-seam weld shown at *(i)*, Fig. 6, is made without any filler rod with oxyactylene, or the electric arc with carbon arc.

Fig. 7 depicts five welds which may be used as head welds; *(a)*, *(b)* *(c)* are flat heads and may be used as tube sheets if desired. Joints *(d)* and *(e)* may be used either for flat or dished heads; when flat the heads may be used as tube sheets. Joints *(b)* and *(c)*, are used on tube sheets of closed heat exchangers, may have the tube sheets serve as flanges for gasket joints. Flat heads, unless extremely thick and of small-diameter vessels, should not be used unless stayed by tubes or other suitable reinforcement.

Fig. 8 depicts three additional welds which may be used on gasket joints only.

All the head and girth seams shown may be used in conjunction with any of the seamless or welded (not fused) longitudinal shells to form the completed vessel, or they may be used for the same purposes on fusion-welded longitudinal shells.

The grades of plates used may be tank, welding, firebox or flange steel, the minimum tensile strengths of which are, in pounds per square inch, 40,000, 45,000,

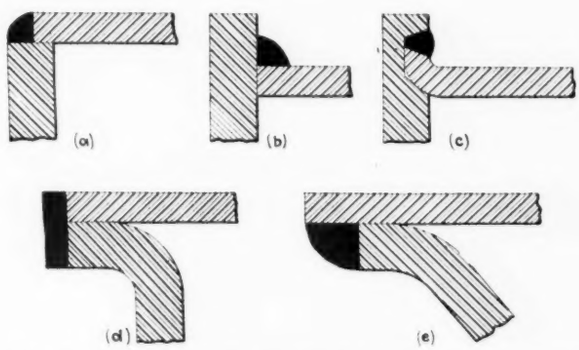


Fig. 7—Five methods of attaching head by welding

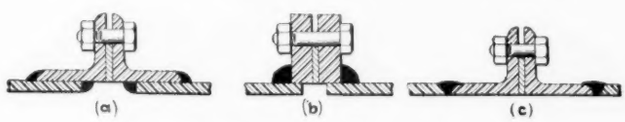


Fig. 8—Three types of gasket welds

55,000 and 55,000 respectively. If vessels are designed according to the Pressure Vessels Code, a tensile working stress of 5,760 lb. per sq.in. must be used. The use of this stress for circumferential joints will not be found to be a limitation for Code designed vessels, for this stress is over half of the 9,000 lb. permitted in seamless shells and the 7,650 lb. permitted in welded (not fusion) shells.

However, if the Code is to be revised to permit longitudinal-joint fusion welding and the working stress is kept at 5,760 lb., the welding of longitudinal seams will present no economic advantage, for the gain in fabrication is more than offset by increased cost of

thicker shells. In short, it would be cheaper, with these limitations, to use a seamless, welded (not fusion) or riveted shell. The working stress advocated by the American Welding Society is 8,000 lb. per sq.in. for the double-V weld, which would place welding on a competitive basis with the other methods of pressure-vessel construction.

Fig. 9 is a fusion welded air tank designed for 125 lb. pressure. It is the same size and constructed to withstand the same pressure as the riveted tank shown in Fig. 3 of the previous article. The working tensile strength used is 8,000 lb. per sq.in., and the longitudinal and girth seams as well as the 12-in. outlet are not in accordance with the Pressure Vessels Code for the reasons given. The heads are designed in consideration of certain recent experiments as reported in *Power*.

To the designer and plant operator a large variety of pressure-vessel construction methods is today available, all of which have something or other to recommend them. At the present stage of engineering no vessel should be designed and purchased simply because similar vessels have been so fabricated in years gone by. A thorough investigation should be made of all methods in use today. If this is done, it will be found that there is one or the other or a combination of methods of fabrication which will best satisfy one's requirements, whether they be for an ideal pressure vessel or low first cost.

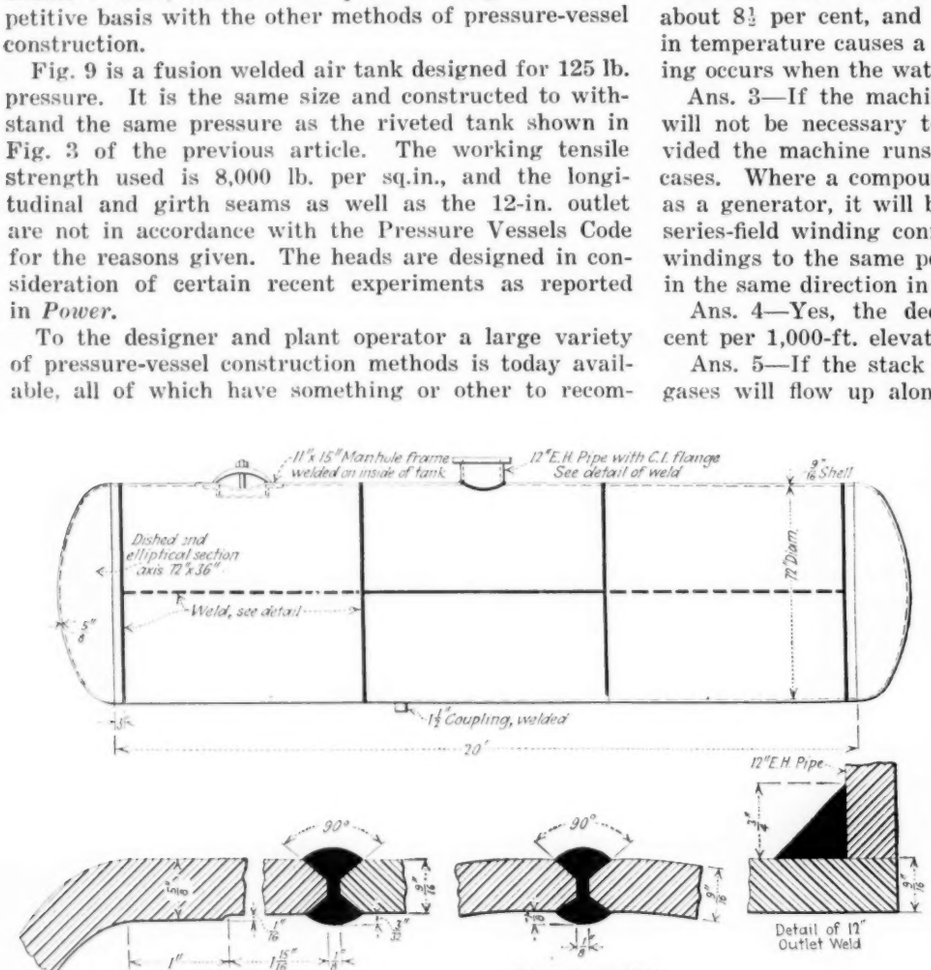

11"x 15" Manhole frame welded on inside of tank
12" E.H. Pipe with C.I. flange See detail of weld
9" 16 Shell
Dished and elliptical section axis 72"x 36"
Weld, see detail
72" Diam
1½" Coupling, welded
20'
12" E.H. Pipe
90°
90°
Detail of Head and Girth Welds
Detail of Long. Weld
Detail of 12" Outlet Weld

Fig. 9—Welded air tank designed for 125 lb. pressure

ACCORDING TO PRESS REPORTS, borings have been made in the Kamodjan crater, near Garvet in the interior of Java, to determine if steam can be profitably obtained. These borings, which were pushed to a depth of over 500 ft. tapped sources of steam at a pressure of some six atmospheres. The steam wells in Sonoma County, California, have disclosed pressures ranging from 64 to 276 lb. per square inch. The Lardevello natural steam plant in Italy described in *Power*, Nov. 24, 1925, operates on lesser pressure. It is said that the steam from Java wells will be used in the power station of the Garvet-Tjikadjang Railroad.

A Check on Your Answers

Ans. 1—A bracket used to take the thrust of a ratchet drill.

Ans. 2—When water freezes, its volume increases about 8½ per cent, and after ice is formed a decrease in temperature causes a decrease in ice volume. Bursting occurs when the water at 32 deg. F. solidifies.

Ans. 3—If the machine is the simple shunt type, it will not be necessary to change any connections provided the machine runs in the same direction in both cases. Where a compound motor is changed to operate as a generator, it will be necessary to interchange the series-field winding connections, to bring the two field windings to the same polarity, if the machine operates in the same direction in both services.

Ans. 4—Yes, the decrease is approximately 3 per cent per 1,000-ft. elevation above sea level.

Ans. 5—If the stack is too large, the column of hot gases will flow up along the center and a column of cold air will descend along the sides. This will set up eddy currents which will destroy the draft in the furnace. However, if the height is greater than would ordinarily be figured for the required draft, this may overcome the effect of excess area. See *Power*, March 29, 1927, p. 490.

Ans. 6—A reaction turbine is one in which the steam passing through the moving blading develops increased relative speed, so that the force required to accelerate it pushes back, or "reacts" on the blading, and pushes in the direction of rotation. In other words, a reaction turbine is one in which there is an appreciable drop in steam pressure across each row of moving buckets.

Ans. 7—The detaching of the valve from the gear through the action of the governor, the closure of the valve by dashpots and the use of a rotary valve to permit a sharp cutoff.

Ans. 8—With 70-deg. water, the gallonage ranges from 2.5 for double-pipe to 3.2 for bleeder-type condensers.

Ans. 9—The water in the column is colder than the water in the boilers, consequently it is at a level slightly below the true boiler level. After blowdown, the column contains water at boiler temperature, so that the level shown by the gage is the actual boiler level.

Ans. 10—Newcomen and Savery invented the first working steam pumping engine.

THE OIL-PIPE LINE COMPANIES first showed interest in the oil engine for pumping service in 1913, and after the initial troubles had been overcome, rapidly replaced existing steam pumping engines with Diesel units. Of the new pipe lines installed since 1917, all have been equipped with oil engines, there being a total of 236,020 hp. in use.

* For the questions see Page

Welding Pipe Joints

THE question of joints in the pipe lines of the modern central station is becoming increasingly important as temperatures, pressures and pipe sizes increase. The cost of the ordinary flange joint under these conditions makes welded joints seem exceedingly attractive. On the other hand, the uncertainty of the character of the weld, the difficulty of detecting defects and the dependence placed on the human element are factors which many engineers believe act against the adoption of welded joints. Considering the low stresses existing in well designed pipe lines, these fears may be too conservative, as it is evident that a number of minor defects could exist in the welded joint of a large pipe without seriously increasing the stresses in the more perfectly welded parts.

Although welding steam pipes is comparatively new to central stations, one station has used welded joints for all its piping including high-pressure steam mains and others are employing it to a lesser degree. From the somewhat greater experience of oil refineries with this type of joint the central station engineer may obtain considerable of value.

Careful training of men, constant supervision and continued improvement in methods and equipment may be expected to result in the elimination of welding defects.

Modernization Trends

SUBSTITUTION of seven large boilers and three turbines in one centralized plant in place of more than a hundred smaller boilers serving a number of scattered steam-engine drives at the Colorado Fuel & Iron Company, as related in this issue, is representative to a greater or lesser degree of what is going on in industrial power plants throughout the country.

The average steel plant covers a vast area. Extensions from time to time have necessitated additional power units, which as a rule have been installed to meet the demands of the moment without any very definite power plan. Inevitable waste in generation and distribution result until there comes a day of reckoning, which is answered by a new or revamped power plant, incorporating the latest design and electric drive.

The same picture applies to paper mills, chemical plants, textile mills and innumerable other industries.

What does this evolution mean to the management, to the operators, and the equipment manufacturers?

A handsome saving in fuel, labor and maintenance costs, together with increased production, is the management's reward. As for the operators, here is an opportunity for the man who has fitted himself to assume the greater responsibilities incident to the operation of the modern plant. Obviously, the manufacturer of up-to-date equipment also profits, which fact should offer an incentive to further improvement to keep abreast of more and more exacting demands.

Bearing in mind that the total power of the country is steadily increasing, those who are looking ahead and preparing to lead rather than lag face an exceptional opportunity; for managements are becoming convinced that they can no longer ignore the handicaps of antiquated power generation methods.

A Little Oratory Would Help Engineers

AT A recent engineering meeting a man in charge of sales for a large company gave the principal address. In the discussion a remark was made that should be taken to heart by many engineers. Without attempting to quote literally, the speaker said that he never could understand why a salesman could talk so much better than an engineer, and it was his feeling that if engineers did not speak any louder in asking for salary increases than they did in addressing a meeting, it was no wonder their pay was so low.

Possibly some salesmen do use the loud speaker too strenuously, but it must be admitted they receive attention. Probably the difference in voice is traceable to the dissimilar mental attitudes. To be a salesman one must be convinced that he knows as much, if not more, about his own product than anyone within sight. The engineer, more cautious, or possibly more inclined to acceptance of evident facts, has a feeling that somewhere within hearing is hidden another who has superior knowledge on the discussed subject, and is awaiting to spring from the ambush. Engineers should absorb a little of the Babbitt psychology.

An Engineering Job Partly Done

A GREAT deal of attention has been given to the design and operating technique of power plants to obtain the highest economic efficiency, and this effort has produced remarkable results. By some peculiar twist in engineering thought, while extensive effort has been made to produce a kilowatt-hour at the highest economy, less attention has been given to learning how much of the kilowatts leaving the generator terminals reaches the utilizing devices.

Cases are on record where there were over twenty per cent losses between the watt-hour meters in the power station and those on the receiving end of the system. This does not tell the whole story, since, to these losses must be added those within the customer's premises, which, combined with those outside, may account for nearly thirty per cent of the power leaving the generator terminals. In other words, after making every effort to supply the power most economically, nearly one-third is lost by the time it reaches the utilizing devices. This is a condition common to both cen-

tral distribution systems and industrial plants.

The sources of these losses are many, such as conductors too small, transformers too large or not located properly, obsolete high-loss transformers, grounds, poor insulation, poor connections, equipment not designed for the voltage and frequency, unbalanced loading, etc. The utilizing equipment is frequently the cause of considerable loss. It is not uncommon to select a motor one or two sizes larger than required to carry the load and then select the minimum size of wire for the feeders and motor connections. This practice is just the opposite from what it should be if efficient distribution and utilization of power are to be obtained. Any increase in the size of a motor above that required to drive a given load decreases the efficiency of power utilization. The larger conductors are made the lower the losses will be, provided all other conditions are equal. There is, of course, an economic limit, but a common practice in selecting conductors for power distribution lines is to stay far under the economic limit rather than exceed it.

Undersized lines are frequently the cause of unsatisfactory operation of motors and other devices. Not only does the torque of induction motors fall off rapidly with the voltage, but the candlepower of lamps is also very sensitive to voltage changes. A five per cent decrease in voltage below normal causes about seventeen per cent decrease in the candlepower of a tungsten lamp. With large conductors the better voltage regulation at the equipment will result in improved service and in many cases an increase in production. Where oversize induction motors are used, not only are the power losses increased owing to the lower efficiency of the motor, but the low power factor is reflected in increased losses all the way back to the generator. The low power factor also affects the voltage regulation and makes it more difficult to maintain good service conditions.

There has been a tendency to think that the only place that fuel could be wasted or water used inefficiently, was in the power house. But power uneconomically utilized after it leaves the generator terminals, results in losses equivalent to those in the power house due to inefficient use of the basic sources from which the power is produced. Until the same careful attention is given to utilizing the power economically that has been used in producing it, the engineering job is only partly done.

What Does Education Do for a Man?

IN DISCUSSING the machine-like standardization of the training given by present-day colleges, especially in the fields of science and engineering, an editorial writer in the *New York Herald-Tribune* says that "To every experienced factory manager it is a commonplace that his best assistants and most brilliant engineers are not from the colleges, but are self-trained climbers from the ranks." What nonsense!

Of course there are men of limited capacity who graduate from our colleges and men of overwhelming ability who have not had the help that college could have given them, but that has nothing to do with the matter. The simple truth is that what goes to college comes out of it. No college course in the world can create new traits in its students. It can and it does develop what the student has and enable him to make the most of his talents, but talents he does not possess cannot be grafted onto his character in any school. He must do his best without them.

Anybody with sufficient money can collect a splendid outfit of machinist's tools, and he may know the names of all of them and what they are used for and where to go to find other tools whose names and uses he knows, but this will never make him a good machinist. A skilled man with a cold chisel can do a better job finishing a flat surface than a clumsy man with a whole assortment of files and scrapers. More than this, there are men who seem incurably unhandy with tools, who seem never to be able to do a thoroughly good job of an exacting sort. They are apparently just naturally unskillful. Tools are easily acquired. Skill must be born in a man. Training will develop it, but it cannot make it from nothing.

The engineering college can develop a man's inborn capacity for effectiveness among his fellows to a high degree. It can give him a whole kit of elaborate tools, with instructions how to use them and with suggestions of where to go to find other tools not included in the usual outfit. And the school can give him a bit of practice in using the more common tools, so that he may develop some measure of skill if he has it in him at all. Above all, the school can train the man of capacity to think straight and to use intelligently information that comes to him, sought or unsought, from all manner of sources. To be sure, the capable man might acquire all these things by himself, but the process would be far slower and more difficult, with danger that it might be one-sided.

The young graduate comes forth believing that he is destined to conquer the world, and all that, but these illusions presently evaporate, and the hard realities come to the fore. It develops that some of these men had it in them to rise to the top, and that others didn't. Some seem to know how to use their tools, others seem always to hit their thumb with the hammer. It is not always the brightest man in the classroom who proves to be the best engineer, nor, be it noted, is it by any means always the dullard. Surprising reverses have been known, but by and large a man of innate ability will display it in whatever he tackles, whether it be learning mechanics or managing the student baseball team or running a department or a corporation.

Then does college training make no difference? Much in every way. A good machinist can do a better job with good tools than with poor ones, with sharp tools than with dull ones, with experience at that kind of work than without it. There seem to be certain qualities in men that mark them for success, given opportunity at the right moment, and many succeed despite severe handicaps. Such are the men that the technical school can help to grow into broader fields of service.

It is not safe to assume that the college graduate is a better man than his unschooled brother. It is not safe even to assume that he knows more. Of course he thinks he does, but if his brother is an alert man, the fact probably is that the graduate simply has a different body of knowledge, in no wise superior, but simply different. One knows how to find trouble in a Corliss engine and how to operate a boiler room. The other knows how to go about planning a power plant to develop high efficiency with a complicated heat balance and how to design a system of instruments and controls. Either alone is one-sided. It is the man who combines in effective measure a grasp of both aspects of the job who is the first-class engineer.

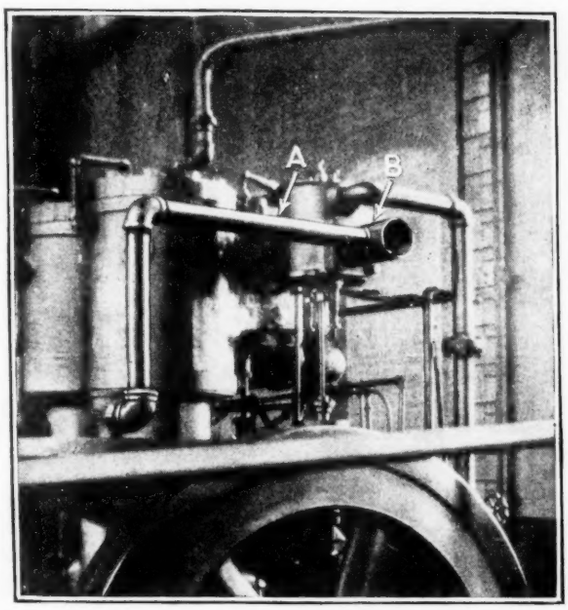
Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Burning the Gas-Engine Crankcase Vapor

From a number of years' experience in operating gas-engine plants I have found it an advantage to pipe the crankcase vent to the air intake pipe. This relieves the crankcase of an explosive vapor, and at the same time the vapor serves to lubricate the governor mixing valve and enrich the mixture. It has long been known that the oil vapor in an inclosed crankcase of a gas engine is explosive, and many engineers have been burned from this gas becoming ignited.

The suction on the air intake, with what little air passes through the bearings, keeps the crankcase free



Crankcase vapor vent connected to air intake

of any gas, and the occasional change of air in the crankcase helps to keep it cool. Then this oily vapor passing through the mixing valve tends to keep the valve working freely, whereas with the dry air and gas only going through the valve, it becomes sluggish and has to be regularly taken out, cleaned and lubricated.

Some years ago I operated a large gas-engine plant in Pittsburgh, and in this plant the air intake for the engines was piped from below a grating in the sidewalk, consequently much fine dust of the street was drawn in. During the first four years the plant was operated, it was necessary to pull out the mixing valves every week, but after piping the crankcase vapor to the air intake, the engines would run four to six months without trouble and when the valves were taken out they were found covered with a soft oily soot.

The illustration shows how the vapor pipe is connected on one type of engine. The relief chamber is mounted on the engine platform, and the vapor pipe *A*, which in this case was 2½ in., was welded into a 5-in. nipple *B* leading into the air inlet of the engine. This slight suction on the crankcase keeps down many small oil leaks around the bearings and relieves the engine room of a smoky vapor, in places where the vapor pipes cannot be run to the open air.

L. M. JOHNSON.

Sewickley, Pa.

Change to Correct Firing Makes Big Saving

Attention to details in the firing of boilers or the operation of stokers is necessary if the best results are to be obtained. Putting coal on the fire and then letting nature take its course in burning it, is likely to be wasteful of fuel.

It occurred to me that the simple way in which the coal consumption on four 1,500-sq.ft. return-tubular boilers, was cut three tons in eight hours, might be of interest to other readers. The boilers were equipped with V-type stokers operating with natural draft. The average load on the boilers was around 150 per cent of rating, and the steam was used in four automatic cutoff engines running non-condensing, and for process.

When first on this job I knew nothing of automatic stokers, but by securing a catalog and studying it, I better understood their operation and construction. After several weeks of practical instruction I began to put theoretical ideas to work. By keeping the fires light, about 4 in. thick, the steam pressure was maintained practically constant. The former firemen kept the fires heavy and this necessarily filled the center of the V and caused clinkers.

My method of firing was to start at No. 1 boiler and work down the line to No. 4, slicing each side of the furnace. Then going back to No. 1, I would take a piece of bent ½-in. pipe and poke the coal that had coked in the corners of the magazines. On the fires that were a little too heavy I would shut off the coal feed for a short time, while on the light fires a little more coal would be shaken down. Of course this is the normal way of operating this type of furnace, and most firemen start out this way but soon take the path of least resistance—firing heavy. With firing heavy, the fire soon becomes clinkered and reduces the output of the boiler, while light fires allow the accumulation of ash and small clinkers to be taken care of easily by the clinker grinders.

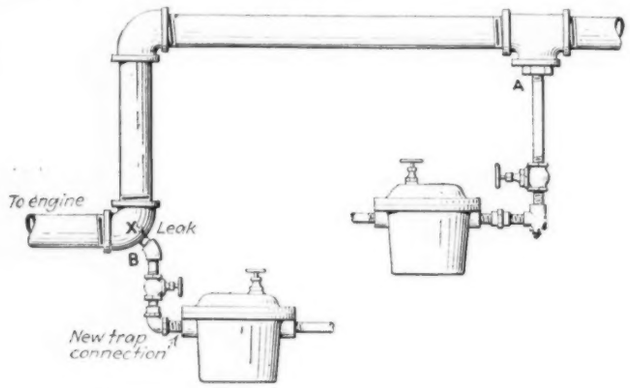
The light method of firing keeps the fireman on his feet but brings its reward. For instance, in one week of firing on the day shift of eight hours, I saved 17 tons of coal, with an average daily consumption of 18 tons of coal per eight hours. At the end of the month the chief was so pleased that he had my pay raised $7 a week.

JOSEPH O'BRIEN.

Rosedale, L. I.

Location of Trap Connection Important

A trap was connected to a 4-in. line supplying steam to a high-speed engine as shown at *A* in the sketch. At heavy loads the engine developed a pound in the cylinder which I always insisted was caused by water in the steam, but I was overruled by the master mechanic, who insisted that no water could get past the trap. I suggested reconnecting the trap to the line at



Change made in location of trap connection

the point *B*, but was laughed at, until an accident proved my claims.

Steam started blowing from an elbow in the line between the trap and the engine and on investigation proved to be coming through a pinhole. The elbow had been renewed only a year before, but after shutting down that night, the elbow was struck with the ball peen of a one-pound hammer, and it crushed like an eggshell at the point where the leak started. The scouring action of wet steam was no doubt responsible for this, the water being hurled against this point when the steam path turned through 90 deg.

A new extra-heavy elbow was drilled at the point indicated for the trap connection, and the rise in temperature of ten degrees, in the tank which supplied a mixture of returns and makeup water, proved definitely that more high-pressure returns and less cold makeup were entering the tank. At the same time the cylinder pound disappeared, and we found we could run on less cylinder oil. G. H. HART.

Thompsonville, Conn.

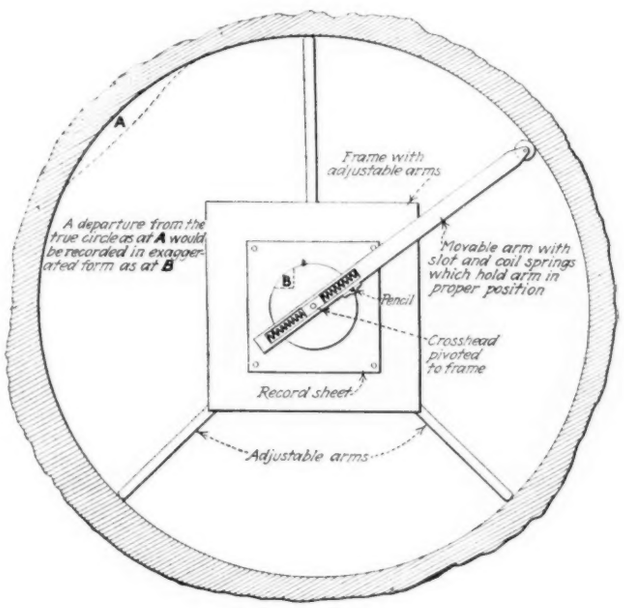
Recording Defects in Equipment for Future Reference

An engineer, upon taking charge of a new plant, should be careful in his examination of all equipment, and should he find any important defects that cannot be remedied at once, he should record the fact for future reference.

The following incident, related to me some years ago by a prominent marine engineer, impressed me with the importance of the foregoing statement, and I am passing his experience along so that others may profit by it.

The engineer in question was appointed chief of a large, comparatively new turbine-driven ship. As turbine-drive was a new thing at that time, and this being his first berth as chief, he realized that the equipment in his care would be watched with considerable interest, consequently, upon taking charge he examined everything thoroughly.

The ship was equipped with Scotch marine boilers. He found many of the furnaces slightly down or considerably out of round. The boilers had just been passed by the inspectors, and their reports made no mention of the condition. As the boilers were in no immediate danger and sailing time was close, he decided to record the condition for future reference. He constructed the three-armed frame shown in the sketch. The arms were adjusted so that the center or pivot of the revolving arm was approximately in the center of the furnace. It was not found necessary to locate the pivot exactly in the furnace center; any close approximation of an inch or so was sufficient. The revolving arm, fitted with a wheel at its outer end was pivoted to the center of the frame by means of a pin and sliding block and held in position by long coil springs. The arm carried a pencil which recorded the travel on a sheet of paper tacked to the frame. As the arm moved around the furnace, a record was established on the paper. If the furnace was exactly round, the record would show a true circle, but any irregularity in the circumference of the furnace would be exaggerated on the record sheet, this exaggeration increasing as the diameter of the recording circle was decreased by shifting the pencil toward the pivot; in fact, some of the records taken using a pencil position near the pivot, actually appeared as the figure 8. Several records were taken in each furnace; notes were written on each record as to the exact location at which


A
Frame with adjustable arms
A departure from the true circle as at A would be recorded in exaggerated form as at B
Movable arm with slot and coil springs which hold arm in proper position
B
Pencil
Crosshead pivoted to frame
Record sheet
Adjustable arms

Device used to record out-of-round of boiler furnace

it had been taken, and they were filed in the captain's office.

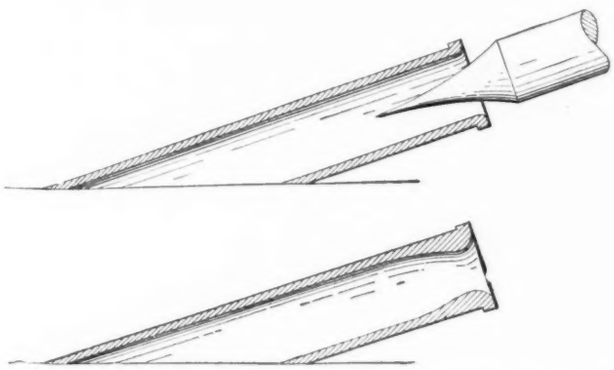
At the next inspection in the same port the inspector notified the captain that the ship could not sail before the boilers were repaired. The chief was called, and he asked the inspector why he had not held the ship up at the time of the last inspection. Needless to say, when the records were shown and some new ones taken without showing any change, the objection was withdrawn and the ship sailed on time. Had records not been taken, a new engineer would have taken the ship out on that trip. A. C. MCHUGH.

Norwalk, California.

Comments from Readers

Steam-Turbine Nozzles

I have just been reading an editorial on steam-turbine nozzles that appeared on page 450 of the March 22 issue of *Power*. In the second paragraph of this editorial is a reference to a circular nozzle in which the throat and diverging section are formed by a central tapered pin, whose position is adjustable from out-



The needle valve nozzle shown above is equivalent to the poorly shaped nozzle below it, so far as area variation is concerned

side the casing so that the nozzle can be set for various pressure conditions.

I have discussed this nozzle with a number of engineers, at least one of whom is very familiar with the needle-valve nozzle put out a number of years ago. The consensus of opinion seems to be that this nozzle is extremely inefficient. For a given throat area the metal periphery in contact with the steam is much greater than in the conventional type of reamed nozzle, and, accordingly, the skin friction is materially increased. Also, the contour of the needle-valve nozzle is much like some of the long and inefficient nozzles used in the early days of the steam turbine.

Further, it is questionable whether these nozzles would be correctly adjusted by the operator, and if the correct expansion ratio were not secured, serious loss would result. In other words, there is danger that an adjustable nozzle will always be adjusted wrong.

Boston, Mass. W. T. FERGUSON.

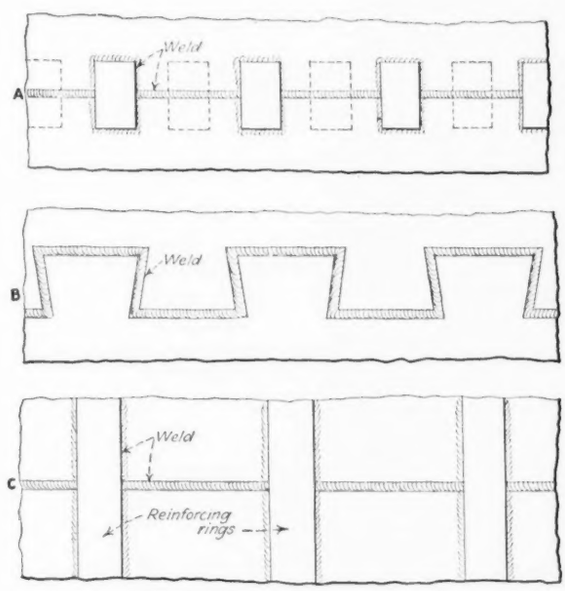
Boiler-Shell Joints, Rivets, Welds and Dovetails

In the April 5 issue J. M. Brennan discusses the welding of boiler joints in a tone rather discouraging to proponents of welding. The kind of joint that would be acceptable to Mr. Brennan would be out of the question in practice because of its cost. If welding methods can be adopted only at the cost of such welds as proposed, then progress, so far as welding is concerned, may as well take off its hat and sit down.

In the dovetail joint illustrated by Mr. Brennan (and reproduced herewith) as an acceptable one, the width of the root of the dovetail is about 40 per cent of the pitch, and the length of the weld around the three sides of the dovetail is three times the width of the dovetail. Should this joint fail along the weld and through the root of the dovetail, then the strength of the plate at the root of the dovetail would be developed at the cost of three times its length of weld—a 33 per cent efficiency you might call it.

Another "acceptable" weld is a butt-weld reinforced with rings that circle the shell and are welded along both edges. Assuming the outside diameter of the shell as 36 in., and the rings of ½x4-in. steel plate, then the strength of the 2 sq.in. of parent metal in the ring is developed at the cost of 226 lin.in., or 30 sq.in., of weld metal. Should such rings be desirable, it would only be necessary to tack-weld the edges at intervals—short straps, however, would be sufficient.

In much of the discussion of welded versus riveted joints we are met by demands that the weld be "perfect," "absolutely reliable," "faultless," etc. A riveted joint may vary between 57 and 88 per cent of the



Welded drum seams

A. Seam with small reinforcing plates as used abroad. *B*. Dovetail joint suggested by Mr. Brennan. *C*. Welded seam reinforced by rings.

strength of the plate, but a welded joint, to be acceptable in some quarters, must be "perfect"; meaning thereby, I presume, 100 per cent efficient.

Tests of riveted joints have seldom developed the strength found from calculations of the strength of the ligaments, shear of rivets, etc. The deduction is that secondary stresses are set up by forming, punching, drilling and riveting, that reduce the net strength of the joint—a departure from the "perfection" often assumed for riveted joints.

Riveted joints are subject to "slip"; that is, an adjust-

ment, or accommodation of rivets to imperfectly filled holes. Where this slip occurs, there is sometimes a leak. Sometimes the leak occurs on the testing floor with the boiler under water pressure, so the seam is calked tight; sometimes the leak develops with the boiler under steam pressure, and the operator is given some uncomfortable half-hours assuring himself that the leak has no special significance.

It is true that the personal element enters largely into the matter of getting good welds; also, that inspection of the finished work does not reveal hidden defects or failure to fuse and fill the joints properly. In this respect it seems anomalous that welders will slight their work, with development of the art so dependent upon good results—a strange blindness to one's interests.

I know of a few failures of welded work. These were due to an evident lack of knowledge of structural mechanics and not to welding as such; yet welding received a "black eye" by reason of the failures.

In the A.S.M.E. unfired pressure-vessel code the permissible stress in a welded shell is 5,600 lb. per sq.in. On the basis of a working stress of 11,000 lb. in the shell plate, this is an efficiency of 51 per cent, which is less than the efficiency of a single-riveted lap-seam. I cannot see the logic of such a handicap on welded joints. If they are so uncertain as implied, then they should be forbidden altogether. Fixing the efficiency at 51 per cent, or even less, cannot insure us against poor work. On the contrary, it is likely to produce poor work because the operator's goal is the production of a joint that will develop only half the strength of the parent metal. My experience and observation do not impel me to a belief in the existence of an urge on mankind to spend a maximum effort on a minimum result.

Most manufacturers engaged in the production of welded articles realize the importance of good work and strive to attain the best results; any other course would only justify the seeming prejudice against welding in some quarters. Just how much of this prejudice is warranted and how much is actuated by commercial considerations, is not settled in my mind. I am of the opinion that the fear sometimes expressed of welded joints has something in it besides good wishes for this important advance in mechanical engineering.

Los Angeles, Calif. C. O. SANDSTROM.

Important Questions for the Chief

Farsighted engineers in the power plant are constantly taking steps toward self-improvement, and this suggests volumes. In the business it is hard to pass by some of the old-timers, and others may wonder "how they manage to do it." Some of the others would profit immensely were they to interview themselves once in a while. Let this be done unbiasedly. The engineer who looks facts in the face, sensing his own shortcomings, then takes suitable action, will find himself the gainer. For that reason the following questions are propounded:

Does the engineer, no matter how experienced and long in the game, make it his steadfast practice to study his trade papers, intent on finding the "why" and the "how" on interesting problems, by experimenting, so at the same time he can discover new things for himself? Interesting possibilities here!

Does he clip valuable material and call attention thereto, of subordinates? Does he file articles and items, so he can find a certain clipping when wanted? Does he refer to his clippings from time to time, to brush up and to determine where he has been neglecting things? Wouldn't it be refreshing to go through his trade-paper clippings, particularly when a knotty problem comes up, and at times when his spirits are depressed?

Let the power-plant engineer also question himself concerning his staff. What do they really think of him? What has he done to make each assistant think more of him? What might he do? Is it his practice now to call down an inferior rather harshly, or does he have a heart-to-heart talk, even with the transgressor? Are there too many changes in the staff, and are there entailed too much time, effort and trouble breaking in new men, by reason of lack of proper appreciation and co-operation on the part of the engineer? Here comes an important question: Does the chief himself interview applicants for employment, and does he make it his business to begin a close contact at the start? Wouldn't the newcomer think more of the chief were the latter to manifest some interest in him? I am thinking of that chief engineer who wouldn't deign to speak with the new man, hardly noticing him. Some engineers feel much chagrined because their assistants aren't decently respectful toward them. If that is so, what are the reasons?

Does the engineer bother too much with details, mistrusting help that is capable? Or, on the other hand, does he assign too much responsibility, rightfully his, to his own detriment? If there have been boiler-room accidents in the past, whose fault was it? Couldn't some of them have been avoided by timely overseeing? How often did the chief err? What has he been doing to overcome his own shortcomings? What does he intend to do to better his own position and to bring about general power-plant improvement? Has he any definite intentions here, and does he secure the co-operation of his staff? Does he consider it his duty to solicit suggestions regularly? What has he done to stimulate more interest in the power plant, and what is his staff doing, individually, to better things? Wouldn't there be more team-work were there frequent get-togethers, where each could express his opinions, suggestions, and ideas? Wouldn't it help the engineer to gain a broader knowledge of his staff, and wouldn't the future then be more promising?

And about the purchases. Does the purchasing agent exercise major authority here? Does the engineer prefer to let the purchasing agent attend to this phase all alone? Aren't there regular meetings, where the different executives could contribute their thoughts and point out the possibility of better purchases? If materials in the past have not been entirely satisfactory, whose fault was it? Does the engineer make it his policy to interview salesmen, and does he go into each proposition thoroughly? Has he nodded occasionally, skipping by certain salesmen, whom he felt unworthy? Has he perhaps been slightly prejudiced, to his own loss, to say nothing of the plant's?

Does the engineer compliment a member of his staff who performs an unusually good piece of work, or does he possibly belittle? Wouldn't the staff be more ready with suggestions—and extra work—if they knew their chief would praise them and be appreciative? To what extent has the chief fallen down here? What does he intend to do about it? Wouldn't it make his work easier and be conducive to steady power-plant improvement, if

his assistants knew that he really saw and sensed the value of small duties, however insignificant they might appear to him?

Does the engineer go to other plants to witness how things are done in different places, to discuss problems and to find new ideas? Or does he stick too close to his own plant, apprehensive lest things go wrong? If that is the case, isn't there a possibility of sudden plant predicament when his absence is absolutely necessary? And, if he feels he must be on hand constantly to keep things going smoothly, is it because he has not developed his staff efficiently?

Is the engineer sure he is making individual and plant progress, yearly? If not, why not? Just where has he failed? Is he apprehensive of the future? Does he disparage young blood? Does he fail to welcome young assistants, fearing jeopardization of his own interests? Does he fear he may not be able to keep in step with the new men? If assistants excel him in certain ways does he honestly recognize the fact, and what has he done to "catch up" and possibly in turn to excel? In individual ways each man knows something better than others, and of course therein he cannot be hurdled. However, the engineer can always improve his own standing. He may have been giving too much time and thought to favored problems pertinent to his interests, yet to the neglect of others equally or even more important.

Let the engineer weigh the foregoing questions duly, then decide on some definite action where that action is desirable. The new move will be refreshing, and the engineer will have greater hopes for the future.

Brooklyn, N. Y. FRANK V. FAULHABER.

Keeping the Motor on the Job

The article "Keeping the Motor on the Job," in the April 5 issue brings to mind something that is frequently overlooked in their operation, namely, preventing trouble generally costs a lot less than making repairs after a fault develops into a cause for a shutdown. By some peculiar twist in the psychology of the human, many plant owners will pay $100 for repairs and do it with a good grace, but will object seriously to spending one-half that amount to prevent the trouble. A repair is something tangible, whereas much of repair-prevention work is more or less an intangible quantity, and many do not like to pay for something they cannot see as a concrete quantity. If machines operate year after year without the owners being inconvenienced by their failure, he is likely to feel that they should operate this way and overlook the efforts of those who keep them on the job.

Not only may the insulation on motor windings crack and be impaired by use, but the coils, wedges and bands may become loose. When cleaning the winding, before baking and treating with insulating varnish, the condition of the bands and lacing on the winding should be tested to see that they are tight and in good condition. If they are not, they should be removed. It should also be ascertained if the slot wedges are tight and the coils tight in the slots.

The coils can be tightened in the slots by removing the retaining wedges and putting strips of fiber as fillers in the slots under the wedges. The thickness of the fiber slot fillers will depend upon the amount of movement that the coils have. Where bands are used to hold the coils in the slots instead of wedges, the coils may be tightened in the slots by removing the bands and placing fiber filler strips in the slots and replacing the bands. When putting on the bands, care must be taken to get them on tight.

As suggested by Mr. Mills, it is best to bake the armature before treating it with insulating varnish and then bake it again. The time required for giving the armature a good baking will depend upon its size. Temperature of 200 to 220 deg. F. should be used, and the time of baking before treating with insulating compound, for armatures up to about 15 in. in diameter, made about 12 hours; this time increases to about 24 hours for armatures above 30 in. The intermediate time can be judged by the size of the armature. The time required for baking the winding after treating with insulation varnish, will be about double that of the baking period before treating. It is good practice to measure the insulation resistance of the winding, before and after baking and use this as a guide in determining when the winding is properly dried out.

When the facilities are not available for dipping the winding or for spraying on the varnish, a fairly good job can be done by pouring the varnish over the armature. A container must be provided to catch the varnish as it runs off the armature, so that it can be dipped and poured over the winding again. After the winding has been thoroughly soaked in varnish, it should be allowed to drain until all excess varnish has been removed, which will require from about 15 to 30 min. When the armature is draining, care should be taken to see that it does not lie in a position where the insulating compound can run into a pocket and not get out. Placing an armature in a vertical position with the commutator up will generally insure that it will be drained clear of excess varnish. If varnish is allowed to drain into a pocket and is baked, it will cause unbalance when the machine is running. For this reason, it is always advisable to turn the armature at intervals during the baking process, as this will have a tendency to distribute evenly any excess varnish that might be entrapped.

Cleveland, Ohio. P. W. SAWYER.

Removing a Pump Liner

Referring to H. L. Patrick's reply in the April 12 issue to H. L. Wheeler's article in the March 15 issue, on "Removing a Pump Liner," it seems that a manufacturer that made a practice of sending out liners longer than required must have had a particularly good reason for doing so.

It does not appear that this practice is general with the pump builders of this country. It would not be an easy matter to peen over both ends of liners on small duplex pump cylinders except in those cases where the stuffing boxes are in removable heads.

I believe that in most cases pump manufacturers are boring their cylinders to limit gages and that seamless liners are checked with ring gages for outside diameter, to insure against customers' being disappointed.

Warren, Mass. H. W. HATHAWAY,
Warren Steam Pump Co., Inc.

Power has lately received several inquiries from readers seeking information on the application of bonus systems to power plant operation. At one time such systems were quite popular, but many difficulties were encountered in making them equitable. It is probable that a number are still in existence. Discussion is welcomed from readers who have had experience in this line.

Power Application Feature of A.I.E.E. Regional Meeting

EVER since the initiation of regional meetings by the American Institute of Electrial Engineers about three years ago, the interest taken in these gatherings has proved the soundness of the idea. In many instances they have taken on proportions that would do justice to a national convention, and the regional meeting of the Middle Eastern District, held at the Bethlehem Hotel, Bethlehem, Pa., April 21 to 23, was one of the most successful, with a registration of over 350 members and guests. Four technical sessions were held, at which ten papers dealing with many phases of power distribution and utilization were presented and discussed.

INTERRUPTING capacity and rating of oil circuit breakers, methods of reducing power losses in distribution lines, effects of poor voltage regulation, cost of power losses in feeders that are too small, improvements made in induction motors, operation and application of mercury-arc rectifiers to power loads, application of electric power in industries, exchange of power between industrial power plants and central-station systems, and voltage standardization for alternating-current equipment, are among the subjects discussed.

Circuit-Breaker Development

In presenting his paper on "Circuit Breaker Development," R. M. Spurck called attention to the conditions that govern the design of oil-circuit breakers of a given interrupting capacity, the standardization that has been accomplished in rating of oil circuit breakers and the trends in design to meet operating requirements. The economic interrupting ability of an oil circuit breaker, it was pointed out, is fundamentally a question of control of the gas formed by the arc under oil during specific conditions of circuit interruption.

This gas, which is a mixture of hydrogen, methane and other gases, remains in the form of gas and does not condense. In order to prevent oil throw, breaker structures must be closed. It is necessary, therefore, to provide air space in the structure above the oil to accommodate the gases until they can be permitted to escape through openings provided for them.

The formation of gas during circuit interruption is so rapid that no reasonable openings would permit the gas to escape as rapidly as formed. Hence the need of having an air space as a reservoir for the gas to accumulate in, during the period that the gas is generated, at a rate which exceeds the rate at which it can be released from vents of a practical size.

The desirability of having breakers that do not throw oil is generally recognized. This characteristic is obtained by making the entire breaker structure pressure-tight and providing an opening through a baffle or separating chamber for the emission of the gas from the air space or gas reservoir, after interruption of the circuit has taken place.

One type of separating chamber that has proved effective consists of a tube filled with small quartz pebbles. This tube containing the pebbles is the only opening from the air space to the outer air. To escape, therefore, the gas must pass around the pebbles. As it flows around the pebbles, it is cooled and any oil that may be carried with it is separated from the gas and eventually drains back into the breaker.

Reduction of Feeder Losses

Although the paper on the "Reduction of Transmission and Distribution Losses," by J. B. Moorhouse, dealt particularly with the conditions existing on power lines outside the power plant, the fundamental principles laid down apply equally well to industrial plants. A great deal of effort has been spent on improving the efficiency of the power generating equipment and in operating the plants to maintain best efficiency, but as soon as the power leaves the generator terminals, it is in many cases forgotten. On some systems there have been losses of over 20 per cent between the meters in the power plant and the meters when the power is used. Utilizing transformers of the proper size and correct design, keeping the load balanced on the lines, using wire of ample size and eliminating ground leaks were suggestions made for keeping down distribution losses.

The opinion was expressed that too little attention was given to the selection of wire sizes. An example of this was given in a 25-kw. transformer feeding two balanced three-wire loads, each 400 ft. from the transformer, using No. 4 wire. With the transformer well loaded, an average current of 60 amperes would flow in each branch of the circuit for five hours each day. During the load period the voltage would fall from 230 at the transformer to 218 at the load end of the feeders, which represents an energy loss of over 5 per cent. At one cent per kilowatt-hour this represents an energy loss of $23 per year. If the size of wire is doubled, the voltage drop and energy loss will be cut in half. The cost of doing this will be about $60, representing an interest charge of $3.60, but the reduction in energy losses represents a saving of $11.50. Sizes of wire were recommended for the secondaries from transformer wires as follows: For 3- and 5-kva. capacity, No. 6 wire; 7½ kva., No. 4; 10 and 15 kva., No. 2; 25 and 37½ kva., No. 0; and 50 kva., No. 00.

D. F. Alexander, in a paper on "Recent Improvements in Large Induction Motors," described some of the late developments that have been made in induction motors to improve the ventilation, coil design, insulation, starting characteristics and mechanical features of the machine. Although the general arrangement of the motor has changed little during the last twenty years, improvements in the electrical design and distribution of materials have resulted in motors having one-third to one-half the weight per horsepower of the early types.

Ventilation of Motors

Better ventilation has been one of the outstanding improvements. In the older types little attention was paid to this feature, and as a result, sections of the winding at considerable distance from the path of the ventilating air had a much higher temperature than in the more favored sections. The winding and core of modern motors are so arranged that there is a good circulation of the ventilating air not only around and through the end connections of the windings, but also around and through the core, which gives a fairly even temperature distribution through the machine.

Another improvement has been the use of better insulating materials. For large motors mica is used on the straight portions of the coils. On the end of the coils, which are well cooled, treated cloth and tapes are more easily applied and are less expensive. Varnish treatment has added much to the reliability of motors. This treatment is applied in three stages: One, the formed coil before the wrapper or tapes are applied; to the completed coils; and on the completely wound stator or rotor. This varnish treatment consists of drying, dipping, draining and baking. The coils are dried in an oven and dipped in the varnish while hot to prevent re-absorption of moisture. Application of varnish to the finished coils and completed windings seals them against moisture and also gives a glazed surface that is easily cleaned.

Mercury-Arc Power Rectifiers

The paper on "Mercury Arc Power Rectifiers," by O. K. Marti and H. Winograd, attracted considerable interest. These rectifiers, although inclosed in steel tanks, operate on the same principle as the small-capacity conventional type that are inclosed in glass bulbs. Although comparatively new in this country, there are installed, according to Mr. Marti, in Europe and other parts of the world, over 600,000-kw.

capacity of steel inclosed mercury arc rectifiers. They are in use for voltages from 220 to 5,000 and in capacities of from 100 to 2,700 kw., and the range of efficiency is from about 97 per cent for the large high-voltage units to 82.5 for the small low-voltage equipment.

The discussion on the paper, "Application of Electric Power to Anthracite Mining," by E. B. Wagner, brought out the fact that one large company was generating its own power in a plant of 40,000-kva. rating. In this case it was found cheaper to generate the power than to purchase it from the local transmission system. In this plant modern equipment is used to burn low-grade coal that has a low sales value. It was brought out that in mining operations that are not permanent, the cost of power from an isolated plant will increase per ton of coal mined, as the output of the mine decreases, whereas if the power is purchased, the cost will remain fairly constant.

One of the large power consumptions around a mine is for pumping water. According to the figures given, about eight tons of water has to be removed from an anthracite mine for each ton of coal mined. Motor-driven centrifugal pumps are used to a large extent, and these are being made automatic in their operation, so that the functions of starting and stopping the pumps are taken care of automatically even to the priming. This allows the pumping station to be operated without an attendant, which is considered a desirable feature as it eliminates the human element in the handling of the equipment.

"Recent Developments in Electric Drives for Rolling Mills" was the subject of a paper presented by L. A. Umansky. In addition to describing a number of applications of electric motors to rolling-mill drives, attention was called to the fact that the iron and steel industry is the largest single consumer of electric power. In 1924 this was 20 per cent of the total power consumed by all the industries in this country. Mr. Umansky said:

"A modern steel plant, starting with an iron ore as a raw product, produces at its blast and open-hearth furnaces and at the coke ovens a large amount of waste gas or heat. Electricity gives means of conveniently converting and transmitting this potential power to the centers of its consumption. This explains the rapid growth of power-generating plants in the steel mills. One steel plant has an installed capacity of over 100,000 kw. and a number of plants have a demand in excess of 50,000 kw. In 1926 alone the steel industry purchased for its use a 30,000-kw. turbine-generator and three others each rated at 20,000 kw., not counting many other units of 15,000-kw. capacity and less."

In the discussion on this paper attention was called to the increasing importance of interchange of power between the power companies and the large steel-mill power plants, where the waste heat and fuels are available at times to produce power in excess of the mills' needs. One of the suggested difficulties encountered in doing this is that many of the large steel mills operate on 25 cycles, where most of the power company systems are 60 cycles. The equipment to tie these two systems together should not only provide a means of converting from one frequency to another, but should also control the flow of power.

The committee report on alternating-current equipment and system voltage standards, by B. G. Jamieson, of the Commonwealth Edison Co., Chicago, Ill., was presented. This report is based on the suggestions incorporated in the papers and discussion presented at the A.I.E.E. Midwinter Convention held in New York City last February and proposes a system of voltages for supplying equipment that will give utilization voltage for motors of 110, 220, 440, 550, 2,200, etc., and 110, 115 and 120 volts for lighting, the 115-volt standard being preferred for lighting. The voltages are to be obtained by suitable standard voltages for generators and transformers and by a system of taps on the transformer windings to compensate for the voltage drop in the different parts of the transmission and distribution system.

Oil-Engine Conference at Pennsylvania State College

Improvements in Engine Design—Langley Field Experiments—Oil Producers' Problems—Bearing Tests—Penn State Nozzle Research

THE three-day oil-engine conference, April 21 to 23, held at Pennsylvania State College, was the first of the yearly meetings at which the College's engineering and chemistry faculties propose to bring together engine builders and users, oil producers and oil refiners for a discussion of mutual problems. Although the plan was not evolved until a few weeks before the conference date, an encouraging attendance was registered, most of the visitors staying for the entire three days.

Owing to the absence of Pres. R. D. Hetzel, the visiting engineers were welcomed by R. L. Sackett, Dean of the School of Engineering, after which the conference turned to the several papers and resulting discussions, extracts of which follow.

Practical Aspects of Oil-Engine Research

By Edgar J. Kates

For the man of science, research needs no attempt at justification. He is satisfied if he contributes to the store of human knowledge, even though that contribution may have no apparent application to the everyday life of the world.

Scientific research and engineering development involve expenditures of considerable size, and our universities are seldom sufficiently endowed to bear the major burden of the expenses.

An examination of the commercial results that may be the fruit of such scientific endeavors appears to be in order in the oil-engine field. No attempt will be made to prophesy the oil engine of the future, but merely to show how the field of oil engine applications will be enlarged if certain possible improvements in combustion systems are actually achieved. Our attention will be limited, for the sake of brevity, to two roads of progress:

1. To develop the principles of solid injection so that it will equal air-injection accomplishment, in the ratio of power produced to power available in the ideal cycle.

2. To reduce the amount of excess air required for rapid and clean combustion.

The ordinary air-injection Diesel engine of today develops in its motor cylinder about 78 per cent of the power theoretically attainable from the cycle in which it works. On the other hand, the modern solid-injection engine shows in its indicator card less than 65 per cent of the power available in the ideal cycle. It is, therefore, evident that if the solid-injection engine were made to equal the air-injection type in the ratio between actual performance and ideal power output, it would produce over 20 per cent more work with the same amount of fuel and with the same cylinder dimensions.

Under the ratings usually employed, the air-injection Diesel engine has a cylinder displacement about 75 per cent greater than the volume of air required for chemically complete combustion of the fuel supplied at full load. In the solid-injection engine the excess air ratio is still greater, being in the neighborhood of 89 per cent.

There are, of course, several reasons why the cylinder capacity must exceed the ideal requirement, but the most important one is the fact that in the present state of fuel injection and combustion-chamber design it is necessary to supply air in sufficient overabundance so that each particle of fuel is sure to meet its corresponding quantity of air in the time available. If the excess air ratio is reduced, some of the fuel never meets with enough air to burn it completely, and the products of partial combustion—carbon monoxide and carbon—pass off with the exhaust, an utter waste.

But suppose engineers learn how to

do with less excess air. Then engines will no longer have to be built twice as large as the theoretical dimensions. To accomplish this great improvement they must learn how to make homogeneous mixtures of oil and air quickly.

By reducing the excess air ratio to 15 per cent, the size of the engine for the same power output will be reduced by nearly 40 per cent. Combining this with the reduction in size on account of improved thermal efficiency gives a total final displacement of a little less than half that of the ordinary engine of today.

Many important consequences follow. The bore and stroke being reduced to suit the decreased displacement, it becomes feasible to increase the r.p.m. while maintaining the same piston speed. This in turn permits a further reduction in bore and stroke and leads to a much lighter and more compact engine. A fuel economy of 0.30 lb. per b.hp.-hr. is quite possible.

Savings of this magnitude are bound to impress the business man and to open up still larger fields of Diesel-engine applications. Research in the laboratory and development on the test stand will put them within our reach.

In the discussion L. W. Morrison pointed out that as the solid-injection engine with a separate combustion chamber operated essentially on the Otto or explosion cycle, the burning of an increased amount of fuel would raise the final pressure above a reasonable value. An increased clearance could not be used, as this would so lower the compression pressure as to call for electrical ignition. In addition, the theoretical efficiency would be lowered. It was, no doubt, possible to decrease the excess air, but this would necessitate the abandonment of the Otto in favor of the constant pressure cycle. If this be conceded, the excess air percentage of present-day solid-injection Diesels was satisfactory as such engines with a plain cylinder design show efficiencies equal to the air-injection Diesel if the energy of the air jet be accounted for. By the nature of the design of engine having separate combustion chambers, high mean effective pressures and efficiencies were not possible.

Dr. E. D. Ries expressed the belief that engines should be provided with exhaust gas analysis apparatus. If the oxygen and CO_2 contents could be determined while the engine was in operation, existing units could be made to show a better operating efficiency.

Prof. P. H. Schweitzer believed that the solution of lower engine prices would be found in light-weight, high-speed units. Such engines built on a production basis could be sold in competition with high-speed gasoline engines. He stressed the fact that this necessitated a large amount of research.

The oil producer and refiner had his viewpoint presented by Dr. E. D. Ries, Professor of Chemical Engineering, Pennsylvania State College.

Oil Power from the Viewpoint of the Oil Man

By E. D. Ries

The oil industry is older in years of commercial activity than the engine industry. It readjusted itself to the change that took place when a demand for gasoline was created; and its ability to meet this demand was the deciding factor in making the two industries what they are today.

It is certain that the change is coming, and since radical changes in engines will have radical effects on refining, the oil industry should be forewarned in order to be able to meet new demands promptly. In other words, best results can be secured by co-operative work. I therefore wish to add a plea for the closest co-operation between the oil man and the engine man, in order to expedite beneficial advances.

The trend toward fuel oil is shown at present by the inception of Diesel-electric trucks and buses, as well as rail cars. Probably when questions of oil-engine flexibility have been mastered, we shall have automobiles driven by oil engines.

Users of Diesels and other heavy-oil engines are little concerned with questions of volatility, since these engines can handle almost any fuel. The so-called fuel oil used at the present time satisfies the needs, but, assuming a greatly increased demand, will the necessity for radical changes in refinery practice arise, and can these changes be made without great loss to the petroleum industry?

If the demand for fuel shifts from light to heavy, the refiner will have no use for his cracking coils and their obsolescence will have to be charged off by profits from the heavy-oil sales. That this will be a temporary condition goes without saying, but remembering the amount of money involved, the result would seem to be the inforcement of a slow change to heavy-oil engines by the petroleum industry, if for no other cause. Remember also that part of the fuel oil and gas oil cuts now goes direct to cracking coils for producing gasoline, and that a large drop in the demand for the latter would be necessary to make it uneconomical to crack. One other factor in the situation is the trend toward high-compression engines of the gasoline type. This has necessitated no radical changes by the engine manufacturer and now means to the oil man only the question of geographical distribution.

There is another process for producing fuel for oil engines which is now coming to the fore; its raw material is not petroleum but coal. As the result of the work of Fischer, Bergius and others in Europe, new fuels have been developed which are as a matter of fact artificial petroleum. The investigation of these substances has been so successful that at the present time the nature of the product can be fairly readily controlled. The petroleum industry in this country has recognized the importance of this work, and perhaps in the future we may see refiners making their own crude and making it light or heavy to suit their immediate needs. These synthetic fuels are found to be anti-knock in character and are therefore suitable for high compressions.

The trend of engine design is toward heavy oil engines, but this fact will have no influence on the petroleum industry until oil engines have increased sufficiently in numbers to change the fuel demand.

At the Friday session Dean R. L. Sackett of the School of Engineering presided. The first paper discussed was one on bearings by E. G. Gilson, General Electric Co.

What Is a Bearing?

By E. G. Gilson

Although bearings are the oldest part of machines, not much is actually known. Bearing problems are divided into two classes, mechanical and chemical. Usually, bearing designs are worked out by empirical formulas, based on past experience. This is a safe procedure as long as we do not pass the bounds experience has indicated. Beyond this, old laws are likely to break down in some respects.

There are many ways to apply lubricants, but the most common is by the oil ring design. This is satisfactory for low speeds and low bearing pressures, but has its limitations. Centrifugal force, at high r.p.m., throws off most of the oil lifted by the ring and with increased speed the bearings will get less oil.

In investigating bearing pressure, it will be found that for a decided part of the shaft perimeter the pressure is below atmospheric, and at the side where the oil raised by the ring actually reaches the shaft the pressure is decidedly above atmospheric. Consequently, the only oil entering the bearing is that which sticks to the shaft and is carried in by what may be termed the viscous drag of the oil. If the bearing grooving is changed so oil is carried under the shaft to the low-pressure region, a marked change in performance may be obtained.

At first thought it would seem that there cannot be a chemical aspect to bearing lubrication. Let us ask, "Why will not one oil lubricate as well as another?" and again, "Why are organic oils better than petroleum?" "Why is not a solution of sucrose and water as good as petroleum of the same viscosity?" For example, two tests were made on a bearing, the only difference being that in one case the stator was bronze and in the other, copper. The friction curve was much higher for the bronze with a like high temperature curve. As the viscosity must be lower with the higher temperature, we should expect the friction to be lower. This sort of experience disproves the old theory that as long as a good oil film is maintained it does not matter what metals are used.

When the test made was run in an atmosphere of hydrogen instead of air, the friction and temperatures were much higher. It appears that the results can be explained on the basis of chemical reaction. This is strengthened by the appearance of the oil. When the oxidating atmosphere exists, the oil blackens and sludges readily, while in hydrogen no change occurs. Furthermore, with organic oils the friction and temperature effects are reversed from those with petroleum.

In one set of tests a period of hot weather occurred, and when the tests were resumed the friction values could not be reproduced. Evidently, during this hot period something had occurred to cause the friction and temperature to show an increase. In all tests the

oil temperature was from 400 deg. F. upward.

If the hydrogen is dry, higher friction and temperature values appear than when the hydrogen is saturated with water vapor. When a carbon steel shaft is substituted for the nickel steel, the reaction to a change to the atmosphere is not so marked, although always in the same directions. These things seem to indicate a possibility of a chemical reaction between the oil and the bearing surfaces. This is shown by the tests in Table I.

TABLE I—COMPARATIVE FRICTION LOSSES

Shaft	Sleeve	Composition	Per Cent Friction at 60 Deg. F.
Nickel steel	Bronze	Cu 85.59, Sn 10.00, Zn 3.85, Pb 0.34	100
Carbon			91.50
Nickel steel	Brass	Cu 59.15, Sn .39, Zn 39.72, Pb .00	125
Carbon			141.2

Prof. L. J. Bradford in the discussion expressed the view that inasmuch as the recorded temperatures were far above those encountered in actual bearings, the conclusions would not apply to practice. He quite agreed that the temperatures caused a chemical change in the oil, which would account for the variation in the friction load. It was also possible that an electrical effect might set up between the rotor and stator, as oil might change its viscosity if placed in an electrical field, especially if the oil was in the form of a thin film. The results, he felt, were difficult of explanation for at high temperatures the viscosity change is small and the friction should show but a slight variation for a rather large temperature change.

In a paper on "Oil Engines for Automotive Uses," E. B. Neil gave a résumé of steps that have been taken in the development of high-speed engines. Following was a paper on Oil Centrifuges, by Henry Moore, The Sharples Specialty Co. This consisted of an outline of how oil is purified through the action of centrifugal force.

At the final session on Saturday three papers on oil-engine research were presented, Prof. F. G. Heckler presiding.

In 1924 the Engineering Experiment Station of The Pennsylvania State College undertook the building of an experimental equipment for the study of the characteristics of the oil spray, primarily with reference to the injection-type of oil engines. The building of the equipment is now so far completed that actual tests can soon be made and the visitors were permitted to inspect the apparatus. A description of the apparatus will appear in a later issue of *Power*.

Oil Spray Research at the Penn State College

By P. H. Schweitzer

Oil engines generally, and the so-called solid-injection oil engines particularly, have made rapid gains in the last few years, and their importance as prime movers is still growing. Ricardo's prediction made in 1923, that the solid-injection engine would become extremely popular in the near future is being fulfilled in this country. Is the oil engine of today anywhere near perfection? The University of Illinois' recent bulletin "A Thermodynamic Analysis of Internal-Combustion Engine Cycles," by Goodenough and Baker, helps to answer this question accurately. The authors made a very careful analysis of the theoretical possibilities of such engines. Discarding the so-called "air standard" and its modifications, they considered actual mixtures, true specific heats, the effect of dissociation, and the unavoidable afterburning.

After painstaking calculations, they came to the conclusion that for a compression ratio of 12, which is common in solid-injection engines, the mean effective pressure could be as high as 173 lb. per sq.in. in an ideal Diesel-type engine, working with the theoretical amount of air. Even when using 100 per cent excess air a mean effective pressure of 136 lb. per sq.in. is theoretically possible. Today an indicated mean effective pressure of 80 lb. is very good and the majority of the engines sold do not reach 50 lb.

No one can hope that this goal will be reached by a single discovery. Various factors are involved and the progress will probably be a gradual one. The action of the fuel spray before ignition is considered as having a most vital effect on the performance of an oil engine, and it is regrettable that so little is really known about it. How far does an oil jet penetrate in compressed air? What is the shape of the fuel spray? What is the state and size of the globules? How do they change? These are questions we cannot even vaguely answer today although this information is very important to the engine builder and developer in order to control these phenomena.

With our investigation at Penn State we plan to clear up some of these questions and furnish the designers with facts and data that will enable them to construct more efficient and higher-speed engines.

Our experimental equipment consists of a chamber for compressed air or inert gas, devices for the production of fuel sprays, and means for observations and measurements. The apparatus is designed only for the investigation of the oil sprays prior to ignition. No facilities for the investigation of the combustion are included.

In preparing for this investigation, we were confronted with the problem of recording pressure variations which take place in as short a time as one hundredth of a second or less and during which time the pressure rises to several thousand pounds per square inch and drops back almost to zero. Since no instrument seemed to answer these requirements, we developed and built in our shops an indicator that differs radically from existing types.

Co-ordination in Oil-Engine Research

By Robertson Matthews

The widening appreciation of the necessity of extending all fields of research, prompts more attention to the definition of procedure for oil-engine development and of research itself.

In the large organization the definition of the information sought is likely to become diffused by the time it reaches the imagination of the worker assigned to the job. Further, the inspiration and urge of the master mind is, in the large organization, likewise open to exposure to dilution and even to adulteration.

Turning now from consideration of research in general to that of research procedure for oil-engine development, it must be confessed that we have no knowledge of fuel characteristics or of combustion comparable in technical importance and scientific precision with the knowledge at the disposal of the steam-turbine engineer. Fuels are, it is granted, much more complex in composition and behavior than is steam. But does any engineer associated with oil-engine development care to say that his creations do not deserve the support of technical knowledge as much as do those of the steam engineer?

There is reason to believe that, with a given fuel used in an engine with a given type of injection mechanism and means for fuel vaporization, there is a limiting r.p.m. of that engine fixed just as much by the physical characteristics of the fuel as is the r.p.m. of a steam turbine fixed by the physical characteristics of steam.

What procedure is likely to obtain knowledge of fuel behavior of both scientific interest and commercial value to the oil-fuel and oil-engine industries? A vast single organization seems not so advisable as the application of several independent workers. The large experimental engine is probably not an absolute essential. The small engine should be able to verify the findings of bench tests.

During the discussion H. F. Shepherd expressed the belief that the manufacturers were not given credit for the research work actually carried on in the shops. He had spent much time on the study of combustion and atomization, finally concluding that the mechanically operated fuel valve was superior to the spring loaded check.

E. D. Kates related experiences he had had with atomizers with different spray angles and stated he had found that injection in device did not give the same spray formation as when spraying into the atmosphere.

W. F. Joachin gave voice to a desire to discourage Penn State in its engine research. While Langley Field was engaged in spray investigation, the research was directed at the solution of the aircraft engine problem and did not consider the heavier commercial engine.

Doctor Ries felt that if any engine designer believed, as one of the papers indicated, that combustion of solid fuel particles was possible, research and education were decidedly in place.

In reporting, in the April 19 issue, the recent fuels session of the Metropolitan Section, A.S.M.E., J. S. Bennett, of the American Engineering Co., was quoted as having predicted that stokers would be built for burning up to 150 lb. of coal per square foot per hour. Reference to his written discussion shows that he was inadvertently misquoted. What he actually said was that his company is prepared to build stokers that would burn 150,000 lb. of coal per hour in a single unit.

News in the Field of Power

N. E. L. A. Plans Comprehensive Program for Fiftieth Convention

Atlantic City Chosen for Big Gathering of Power, Electric Light and Industrial Leaders—Prominent Speakers Listed—Exhibition to Be Featured

POWER development and the electric light industry in relation to the economic development in the United States during the last ten years will be the main theme of the fiftieth convention of the National Electric Light Association meeting on Young's Million Dollar Pier in Atlantic City, June 6-10, inclusive.

In connection with the convention will be held one of the largest electrical exhibits in the history of the industry. Many of the developments of the last twelve months will be displayed, some of them publicly for the first time.

The program arranged is comprehensive, dealing with practically every phase of the industry, including radio, electrification of agriculture, progress in science and invention, railroad electrification, power co-ordination as a matter of national preparedness and kindred subjects.

Prominent Men to Take Part

For the discussion of these matters there will be many prominent men and women of the country, among whom are listed: Hon. Dwight F. Davis, Secretary of War; M. H. Aylesworth, president of The National Broadcasting Company, Inc.; Gerard Swope, president of the National Electrical Manufacturers Association; J. F. Shaughnessy, president of the National Association of Railroad and Utilities Commissioners; Lovick P. Miles, publisher of the *Commercial Appeal* of Memphis, Tenn.; Governor Albert C. Ritchie, of Maryland; B. C. Forbes, of the Hearst publications and *Forbes Magazine;* M. L. Moon, a director of the American Farm Bureau Federation; Bancroft Cherardi, president of the American Institute of Electrical Engineers; Mrs. Mary King Sherman, president of the General Federation of Women's Clubs; D. F. Kelly, of Chicago, president of The Fair; William Green, president of the American Federation of Labor; E. N. Hurley, former member of the Shipping Board and Emergency Fleet Corp., chairman of the board of directors of the Electric Household Utilities Corp., and others who have indicated that they will speak.

Parade to Open Exhibit

The exhibition to be held in connection with the convention will open the afternoon of June 11 with a parade on the boardwalk. The exhibitors' section of the parade, led by President R. F. Pack and other officers of the association, will start from the outer end of the pier at 3 o'clock, marching to the boardwalk, where it will join with the civic escort section of the parade, including bands and municipal and civic bodies of Atlantic City, including the Mayor, City Commissioners, Fire and Police Departments representatives, civic clubs and hotels and convention bureaus. The parade will march to the Steel Pier and back to the Million Dollar Pier, where Honorable Anthony M. Ruffu, Jr., Mayor of Atlantic City, will greet the delegates. The exhibit will then be officially presented to the officers of the N.E.L.A. and will be formally declared open.

One hundred and ninety-three manufacturers of electrical apparatus, appliances and equipment will display their products at the show. Ranging from microscopic bits of copper wire to electrically operated machines, in addition to practically all known electrical devices of commercial and laboratory use, the displays will include all the improvements and new discoveries of electrical science during the last year. Labor-saving and economy-making equipment for the home will have an important place in the exhibition. All available space for exhibits was reserved several months ago.

Program Outlined

The six general sessions of the convention will be held in the main auditorium of the Million Dollar Pier. These will be on the mornings of Tuesday, June 7, Wednesday, June 8, Thursday, June 9, and Friday, June 10, and the afternoons of Wednesday and Thursday. Parallel meetings of the four national sections, the accounting, commercial, engineering and public relations, will be held on Tuesday afternoon. The public policy meeting will be on Wednesday night. Radio hookups covering practically the whole country will be made for this event.

The president's reception and ball will be held the night of June 6. The entertainment committee has arranged features to fill in the time between business sessions. A New York orchestra will provide music for dancing every evening, except on public policy night.

J. J. O'Brien, president of the Byllesby Engineering & Management Corp., is honorary chairman of the general convention committee, and R. F. Pack, president of the Association, is chairman, and Mrs. Pack is chairman of the hostesses committee.

Officers of the exhibition committee are E. W. Goldschmidt, Wagner Electric Corp., chairman; Frank H. Gale, General Electric Co., secretary-treasurer; and L. W. Shugg, General Electric Co., director of exhibits.

R. J. Graf, Byllesby Engineering & Management Corp., is honorary chairman of the entertainment committee; Thomas Sproule, Public Service Company of New Jersey, is chairman, and W. E. Tait, Public Service Company of New Jersey, is secretary. C. F. Howell and F. S. Delaney, both of the Atlantic City Electric Co., are chairman and secretary, respectively, of the hotel committee. Ross I. Parker, General Electric Co., is traffic manager and has charge of transportation matters, including arrangements for special trains from the West and South.

Advance registration for hotel and transportation accommodations has been heavy and preparations for the handling of at least 10,000 members and guests of the Association are being made.

In addition to the main auditorium on the Million Dollar Pier, where the major part of the program will be given, and the auxiliary meeting rooms where the parallel sessions of the national sections will be held, other special rooms for Association activities will be opened during the convention. These will be the executive offices, the registration rooms, information department and publicity department, all of which will be located at the end of the pier.

Welding in Plant Construction Indicated by Progress

The use of welding as a means of construction of factory and other plant buildings is to be adopted by the General Electric Co. in future building programs, it has been announced by that company. The reason given for this policy is the fact that a study of structural design has shown that company conclusively that the welded structure can be made with less material than the riveted structure for the same loads.

As soon as shop methods are developed it will be possible to fabricate buildings by the use of welded joints cheaper than they can be fabricated by the use of riveted joints, according to the company. This, it is expected, will lead to the use of welding as a means of economy and, in the future, it will be General Electric policy to use this type of structure wherever possible.

Those in charge of General Electric building plans point out that there is no conflict between welding and riveting at the present time, each having its own sphere and continuing to be used. The feeling is, however, that, as welding becomes cheaper than riveting, that method will supplant it.

Welding Society Holds Its Eighth Annual Meeting

The American Welding Society at its eighth annual meeting held last week at the Engineering Societies Building, New York City, stressed the application of welding to structural parts and building construction.

The session at which Past-President E. H. Ewertz presided was devoted to a symposium of the research activities in the welding field during the last three years. Of special interest was the advancement shown in the application of welding to structural steel and the reports of tests made to compare the strength of welded and riveted construction. Other features were the development of automatic apparatus for arc welding long straight seams, improvements in electrodes and high-carbon steel filler rods, the development of methods for spot welding galvanized iron and flash welding tungsten steel to medium carbon steel.

Of particular interest to power-plant engineers was a report of tests by R. R. Moore, showing the effect of repeated stresses on welded tube joints, which indicated that welds have a definite endurance limit similar to steels.

A series of papers were also presented, each dealing exhaustively with one specific application of welding. The applications included welding building steel, welding stern frames, welding in automobile manufacture and the replacing of castings by welded structural parts.

It was reported that no action would be taken by the A.S.M.E. Boiler Code Committee on the society's objections to the sections of the code relating to welding until new tests under consideration had been completed.

The new officers elected for the ensuing year are: F. M. Farmer, president; J. H. Edwards, vice-president; R. L. Shepherd, G. O. Wilson, divisional vice-presidents; J. J. Crowe, W. H. Gibb, H. S. Smith, W. C. Swift, directors.

Continuing the precedent established last year, a banquet and dance was held at the Hotel Commodore, during which the presidential address was delivered by F. M. Farmer.

General Electric Plans New Stations for Buffalo

Two new substations and a 31,500-kw. addition to Terminal Station D are being planned for spring construction by Buffalo General Electric Co. Each of the new substations will have an ultimate capacity of 48,000 hp. and will help to meet the greater demand for electric service which the growth of the city has brought about.

Terminal Station D, on Bailey Avenue near William Street, will have a capacity of 91,500 kw. after the new addition has been completed. A transmission line will be built to connect this station with Terminal C, near Huntley Station on the Niagara River, and improve operating conditions.

Hertel Avenue, a short distance east of Elmwood, is the site selected for one of the new substations.

Buffalo's use of electric service is a barometer of the city's growth. While Buffalo General Electric Co. sold 282,187,924 kw.-hr. ten years ago, last year it nearly trebled the figure with 816,168,802 kw.-hr. In 1916 the peak demand was 65,500 kw.; the 1926 peak was 201,000 kw. The 37,867 meters in service in 1916 had grown to 162,080 in 1926.

Honors Engineers for Service To Czechoslovakia

For eminent service to the Czechoslovak State, six American engineers have received the Cross of Knight of the Czechoslovak Order of the White Lion. They are:

Prof. Joseph W. Roe, head of the Department of Industrial Engineering in New York University; Calvin W. Rice, New York, secretary of the American Society of Mechanical Engineers; Alfred D. Flinn, New York, director of the Engineering Foundation; Lawrence W. Wallace, Washington, executive secretary of the American Engineering Council; H. S. Person, New York, managing director of the Taylor Society; Morris L. Cooke, industrial engineer, of Philadelphia.

The Order was created "in accordance with the approval of the President of the Republic as decoration for citizens of foreign states in appreciation of their services rendered on behalf of the Czechoslovak State."

"Lease N. Y. Water Power Rights; Use Barge Canal" —R. C. Finch

Contradicting the feasibility of the plan for a power authority to operate state water power development in New York, which is urged by Governor Smith, Roy C. Finch, former state engineer, in an address delivered at Rochester, N. Y., April 23, made a plea that the barge canal be given a chance to show its possibilities rather than that the state spend funds on developing other proposed ship canal routes.

"In my judgment," Mr. Finch declared, "the greatest stimulating influence which at this time could be brought to bear on the barge canal would be for the state in no uncertain terms to reaffirm the policy of continuing the present system; maintain it at the highest state of efficiency; make such changes and betterments designed to promote the best interests of navigation; give to this present waterway a fair chance to prove whether or not it can serve as a dependable, ample and economic waterway connection between the Great Lakes and seaboard.

"As to the power development on the St. Lawrence, the objective which must be reached, if the people are ever to receive any benefit, is to get the job done and put an end to the academic discussion which has been going on for years as to how it might be accomplished."

Recommendation that the state "lease the rights to develop the power under the most carefully drawn provision to protect the people's ownership, and that the state be content to control distribution and the rate at which current is sold, collect the $5,000,000 yearly return in the form of taxes, license fees and equity in ownership, and stay out of the power business," was made by the speaker.

Discussion of future ship canal routes through the St. Lawrence or all-American route is hindering the barge canal development, Mr. Finch said, because it is stopping boat builders and operators from building up fleets adapted for canal transportation.

Great Lakes transportation was declared by Mr. Finch to be the cheapest in the world but suitable canal boats must be built and operated, he pointed out, even more cheaply, permitting tonnage from the West being carried to the seaboard by the cheapest possible carrier. That was the plan of those who recommended the barge type of canal, and its success or failure has not yet been conclusively demonstrated, the speaker concluded.

Recent Water Power Project Applications

The Savannah River Electric Co., Greenwood, S. C., has applied to the Federal Power Commission for a license covering a project on the Savannah River in McCormick County, S. C., and Columbia County, Ga. The proposed dam is to be 90 ft. high and 4,200 ft. long. As planned, 34,560 hp. of primary power will be made available, but 120,000 hp. will be installed.

Paul Howard Kollinz, of San Francisco, has applied for a preliminary permit for a project that involves the use of the waters of Long, Crater and Sweetheart Creeks, Speel River and Sweetheart, Crater and Long Lakes, in the Tongass National Forest 25 miles southeast of Juneau, Alaska.

The Bullion Mining Company, Ltd., of Wallace, Idaho, has applied for a license covering a small constructed project on Bullion Creek in Shoshone County, Idaho. The power is used for mining purposes.

G. E. Holds Heating Course

The General Electric Co. held April 18-30 the sixth of a series of industrial heating courses at Schenectady, N. Y. A total of 40 representatives of various central stations throughout the United States attended the course.

Personal Mention

T. F. Leeman, for a number of years associated with the Riley Stoker Corp., and more recently with the Drake Non-Clinkering Block Co., Inc., is now connected with the Rust Engineering Co., of Pittsburgh, and is located in that company's New York office.

Ross L. McLellan, member of the American Institute of Electrical Engineers and formerly managing director of Cia. Westinghouse Electric Internacional, S. A., has been appointed general manager of the Westinghouse International Co., with headquarters in New York. Mr. McLellan, whose appointment was effective April 1, arrived in New York recently from Buenos Aires and immediately assumed his new position. Mr. McLellan is president of the Chamber of Commerce of the United States in Argentina.

William F. Durand, past-president of the American Society of Mechanical Engineers, was recently named by Secretary of the Interior Hubert Work, to serve on the Colorado River Commission.

Julius L. Hecht, vice-president in charge of operation for the Public Service Co., was elected president of the Illinois State Electric Association at its recent annual convention at Springfield. He is a past-president of the Western Society of Engineers and the National District Heating Association, a member of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and is also active in the Chicago Engineers Club.

R. L. Daugherty, professor of mechanical engineering at the California Institute of Technology, Pasadena, is one of seven Pasadena citizens to be elected on the new Board of City Directors, elected under the charter amendment approved by the electorate last November. The new board will elect its own chairman and vice-chairman and will take office May 2. Professor Daugherty is at present a manager of the American Society of Mechanical Engineers.

Society Affairs

American Engineering Council will hold a meeting of the administrative board in the Engineering Societies Building, 29 West 39th St., New York City, at 9:30 a.m., May 13.

American Welding Society, New York Section will meet for the presentation of a paper entitled "The Welding of the Mikelumne Pipe Line," by L. T. Jones and W. S. Weeks, University of California, in the Engineering Societies Building, 29 West 39th St., New York City, at 8 p.m. May 17.

Business Notes

The William B. Pierce Co., 45 North Division St., Buffalo, N. Y., has taken over the sole selling agency for the Conco condenser tube cleaner.

Barker & Wheeler, engineers, announce the removal of their New York office from 90 West Street to 9-15 Park Place, New York City.

The Kaestner & Hecht Co., Chamber of Commerce Building, Pittsburgh, has appointed W. H. Patterson, formerly assistant industrial sales manager of the Westinghouse Electric & Manufacturing Co., Pittsburgh district manager with offices in the Chamber of Commerce Building. This company is a subsidiary of Westinghouse.

The Penn Public Service Corp., Johnstown, Pa., has placed a contract with the Northeastern Piping & Construction Corp., North Tonawanda, N. Y., for the installation of considerable underground steam main work in connection with its district heating system.

The Merco Nordstrom Valve Co. will move its New York office from 110 West 40th St. to 11 West 42nd Street, May 1st.

The Detroit Stoker Co., Detroit, Mich., announces the appointment of A. Kastello as district sales representative for its eastern Canada and Montreal, Quebec, territories, with headquarters at 915 New Birks Bldg., Montreal.

Coming Conventions

American Association of Engineers. Annual convention, Tulsa, Okla., June 6-8; M. E. McIver, 63 East Adams St., Chicago.

American Boiler Manufacturers Association. Annual meeting at French Lick Springs Hotel, French Lick, Ind., May 30-June 1.

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Pittsfield, Mass., regional meeting May 25-27. Summer convention at Detroit, Mich., June 20-24 inclusive; Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Order of Steam Engineers. Annual convention, Moose Hall, 1314 North Broad St., Philadelphia, Pa., June 13-16; J. E. Burke, 1821 So. Ringgold St., Philadelphia.

American Refractories Institute. Spring meeting at Hotel Traymore, Atlantic City, N. J., May 18-19; D. A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh, Pa.

American Society of Civil Engineers. George T. Seabury, secretary. Annual convention at Denver, Col., July 13-15.

American Society of Mechanical Engineers. Spring meeting at White Sulphur Springs, W. Va., May 23-26. Calvin W. Rice, secretary.

American Society of Refrigerating Engineers. Western meeting at White Sulphur Springs, W. Va., May 23-25, in conjunction with the Spring meeting of the A.S.M.E.; W. H. Ross, 35 Warren St., N. Y.

American Society for Testing Materials. Annual convention at French Lick Springs Hotel, French Lick, Ind., June 20-24; J. K. Rittenhouse, secretary, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. W. M. Niesley, assistant secretary, 170 Broadway, N. Y. Annual convention Hotel Sherman, Chicago, June 6-11.

Association of Iron and Steel Electrical Engineers. Annual convention at Pittsburgh, Pa., June 13-18, inclusive.

National Association of Practical Refrigerating Engineers. Annual convention probably in November; E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27; John Topman, secretary, convention committee, Ohio State annual convention in Memorial Hall, Lima, Ohio, June 16-18; P. H. Grigsby, secretary, Lima, Ohio. New England States convention at Portland, Me., June 17-18; Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass. Indiana State convention and power show at Anderson, May 27-28. Plainfield, N. J., meeting at Academy Hall, June 3-5.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., June 8.

National District Heating Association. Annual convention at West Baden Springs Hotel, West Baden, Ind., May 17-20, inclusive; D. L. Saskill, secretary, Greenville, Ind.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Convention at Atlantic City, June 6-10; exhibition, June 4-10.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	April 25 1927
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	1.75
Clearfield	Boston	1.65@ 1.90
Somerset	Boston	1.75@ 2.00
Kanawha	Columbus	1 40@ 1.75
Hocking	Columbus	1.60@ 1.75
Pittsburgh	Pittsburgh	2.25
Pittsburgh gas slack	Pittsburgh	1.60@ 1.75
Franklin, Ill.	Chicago	2.50@ 2.57
Central, Ill.	Chicago	2.25@ 2.50
Ind. 4th Vein	Chicago	2.40@ 2.50
West Ky.	Louisville	1.60@ 1.75
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1	New York	2.75@ 3.00
Buckwheat No. 1	Philadelphia	2.50@ 3.00
Birdseye	New York	1.35@ 1.60

FUEL OIL

New York—April 28, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal.; 36@40 deg., 6c. per gal. f.o.b. Bayonne, N. J.

St. Louis—April 12, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.90 per bbl.; 26@28 deg., $1.95 per bbl.; 28@30 deg., $2.00 per bbl.; 30@32 deg., $2.05 per bbl.; 32@36 deg., gas oil, 4.6c. per gal.; 38@40 deg., 5.7c. per gal.

Pittsburgh—April 18, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6.5c. per gal.

Philadelphia—April 27, 27@30 deg., $2.31@$2.37 per bbl.; 13@19 deg., $1.89 @$1.95 per bbl.

Cincinnati—April 25, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6⅝c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—April 18, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.15 per bbl.; 26@30 deg., $1.20; 30@32 deg., $1.35.

Boston—April 25, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.45c. per gal.; 28@32 deg., 5.85c. per gal.

Dallas—April 16, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

The Brown Instrument Co. has announced the opening of a Cincinnati branch at 718 First National Bank Bldg., in that city, with J. R. Green as district manager.

The Combustion Engineering Corp., Heine Boiler Co., and **Ladd Water Tube Boiler Co.** have their Philadelphia district offices consolidated at 807 Bankers Trust Bldg., Philadelphia, Pa.

The Boiler Engineering Co., Newark, N. J., has secured Rittlemeyer & Co., Bona-Allen Bldg., Atlanta, Ga., to represent it in Atlanta. The Boiler Engineering Co. manufactures the B E C O boiler baffle, which eliminates tiling and provides a positive expansion joint.

The Homestead Valves Manufacturing Co. announces the appointment of the Ziegler-White Co., 155 Second St., San Francisco, Calif., as its exclusive representative in San Francisco and the surrounding territory. The Ziegler-White Co. will carry a full line of Homestead products, including the recently introduced Homestead-Ross stop valves for air lines.

The Timken Roller Bearing Co., at its annual meeting held April 19, reelected all the present officers. H. H. Timken is president; W. R. Timken, John G. Obermier, Marcus T. Lothrop, H. J. Porter and T. V. Buckwalter are vice-presidents; J. F. Strough is secretary and treasurer, and W. A. Brooks is assistant secretary. Directors are H. H. Timken, W. R. Timken, Marcus T. Lothrop, John G. Obermier and J. F. Strough.

The Edge Moor Iron Co. announces that its New York sales office, with J. F. Glenn and H. M. Lodge in charge, and the waste heat consulting engineering office in charge of F. Falla, will be combined and located at 827 Graybar Bldg., Lexington Avenue at 43rd St., New York City.

Trade Catalogs

Rotary Positive Blowers—The Connersville Blower Co., manufacturers of rotary positive pressure blowers, gas exhausters and pumps, Connersville, Ind., has a revised edition of the bulletin describing Victor rotary positive blowers, Bulletin 21C. In it is a new table that illustrates the characteristics of these small rotary positive blowers in handling air through their full range of pressure or suction ratings. The information in the table emphasizes the power economy of these rotary positive blowers not only at their maximum pressure ratings, but also at the lower pressures of 8 to 16 oz.

Equipment for Power Plants — The Worthington Pump & Machinery Corp., 115 Broadway, New York City, recently issued Bulletin H. O. 1900. This bulletin discusses modern power-plant practice particularly with regard to steam condensers, pumps, air compressors, Diesel engines, gas engines and oil and water meters. The bulletin is well illustrated and contains practical information for power-plant and consulting engineers.

K S G Process for Low Temperature Carbonization of Coal — The International Combustion Engineering Corp., International Combustion Building, 200 Madison Ave., New York City, has issued an illustrated pamphlet, No. 1C-3, on this process which was developed in Europe, and a large unit has been in commercial operation at Essen, Germany, for about two years. At the present time a very much larger plant, which will have a capacity of 500 tons per day, is in course of installation at the Ton Phillip Rhondda Colliery, South Wales. The principal feature of this process is the retort shown in Fig. 2. This consists of a double revolving drum, the outer shell of which has a diameter of 10 ft. and is 76 ft. in length. The inner shell has a diameter of 5 ft. 8 in. and is of equal length. All of the constructional features are in accordance with the K S G patent rights.

New Plant Construction

Ark., North Little Rock (Little Rock P. O.) U. S. Veterans Bureau, Washington, D. C., will receive bids until May 24 for the construction of an ice and refrigeration plant at U. S. Veterans Hospital 78 here.

Calif., Los Angeles—W. Bruce, 1121 Pacific National Bank Bldg., Archt., is preparing plans for the construction of a 13 story hotel near Westlake Park. Estimated cost $2,300,000. Owners name withheld.

Calif., Los Angeles — California Club, Hope St., awarded contract for the construction of a 13 story club building at Hope and 6th Sts. to P. J. Walker Co., W. M. Garland Bldg. Estimated cost $2,000,000. Steam heating system, etc. will be installed.

Calif., Los Angeles—Missionary Sisters of the Sacred Heart, is having preliminary plans prepared for the construction of an 8 story hospital on Hill St. Estimated cost $650,000. R. Meier, Title Insurance Bldg., is architect.

Calif., Los Angeles—Southwestern Ice Investment Co., 210 West 7th St., has acquired a site and plans the construction of a 20 ton ice plant on Laguna Canyon Rd. near Laguna Beach. Estimated cost $60,000. Architect and engineer not selected.

Calif., Oakland—J. Enos, c/o St. Anthonys Hospital, is having preliminary plans prepared for the construction of a 16 story apartment on Oak St. Estimated cost $1,500,000. R. G. DeLappe, 1017 Ray Bldg., is architect.

Calif., San Francisco — Stock, Maas & Sauer, c/o A. H. Larsen, 447 Sutter St., Archt., are having plans prepared for the construction of six 6 story apartment buildings at Clay St. and Van Ness Ave. Total estimated cost $1,500,000.

Calif., Ventura—R. F. Rust, c/o Pipe & Kahrs, 441 East First St., Long Beach, Calif., Archts., is having preliminary plans prepared for the construction of a hotel here. Estimated cost $500,000.

Ga., Rome—Southern Railway System, Charlotte, N. C., is having plans prepared for the construction of boiler house, coaling station, etc. here. Estimated cost $125,000. G. L. Sitton, is chief engineer.

Ill., Chicago—Four Hundred Thirty One Oakdale Building Corp., c/o Quinn & Christensen, 360 North Michigan Ave., Archts., awarded contract for masonry, etc. for a 15 story apartment at 431 Oakdale Ave. Estimated cost $1,250,000.

Ill., Chicago—P. F. Olsen, 720 Cass St., Archt., will soon receive bids for the construction of a 13 story hotel including central refrigeration plant, swimming pool, elevators, etc. for Glatt & Molner, 2612 South Michigan Ave. Estimated cost $2,000,000.

Ill., Chicago—Ridge General Hospital, c/o P. T. Johnstone, 190 North State St., Archt., is receiving new bids for the construction of a 6 story hospital at 6542-6614 Ridge Ave. Estimated cost $1,500,000. Former bids rejected.

Ill., Chicago—Sanitary District of Chicago, 910 South Michigan Ave., is receiving bids for the superstructure of a pumping station at Laramie Ave. and Sanitary Channel. Estimated cost $1,500,000. E. J. Kelley, 910 South Michigan Ave., is chief engineer.

Ill., Rockford — Syndicate, c/o Hall, Lawrence, Rippel & Ratcliffe, 123 West Madison St., Chicago, Archts., will soon award contract for the construction of an 11 story hotel at State, Fourth and Market Sts., here. Estimated cost $2,000,000.

Ind., Indianapolis—Court Realty Co., c/o W. F. Johnson Lumber Co., 19th and Monon Sts., is having preliminary plans prepared for the construction of a 7 story apartment and stores building at Meridian St. and Maple Rd. Estimated cost $1,000,000. Architect not selected.

Ind., Indianapolis — Methodist Hospital, 16th and Capitol Sts., is having plans prepared for the construction of addition to hospital, nurses home, power house, etc. Estimated cost $1,069,000. D. A. Bohlen & Son, Majestic Bldg., are architects.

Kan., Atchison—St. Benedict Abbey, is having plans prepared for the construction of a monastery including steam heating system, etc. Estimated cost $1,000,000. E. Breilmeier & Sons, 425 East Water St., Milwaukee, Wis., are architects.

Kan., Dodge City—City is having preliminary plans prepared for waterworks improvements including pump house, pumping equipment, mains, etc. Estimated cost $31,000. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., are engineers.

Mass., Belmont (Boston P. O.)—Dept. of Mental Diseases, State House, Boston is having sketches made for the construction of a hospital on Trapelo St. here. Estimated cost $1,500,000. G. Robb, 15 Exchange St., Boston, is architect.

Mass., Somerset—City awarded contract for the construction of a pumping station to J. M. Darling Jr. Co., 878 South Main St., Fall River. Estimated cost $40,000.

Mich., Detroit—R. T. Lee, General Motors Bldg., is having plans prepared for the construction of a 16 story hotel including steam heating, refrigeration and ventilation systems, boilers, elevators, etc. at West Grand Blvd. and Lawton Ave. Estimated cost $2,750,000. C. Noble, 1009 Lafayette Bldg., is architect.

Mo., Kansas City—W. C. Gunn c/o Defoe & Besecke, 1707 Baltimore Ave., Archts., is having plans prepared for the construction of a 10 story hotel, theatre and office building including separate power plant, refrigeration and ventilation systems, boilers, pumps, elevators, etc. at 36th and Main Sts. Estimated cost $5,000,000.

Mo., St. Louis—A. H. Winkelmeyer, 2602 South Grand Blvd., awarded contract for the construction of an apartment at Grand Blvd. and Sidney St. to Schroeder-Greulich Construction Co., 3111 North Grand Blvd. Estimated cost $150,000. Steam heating and mechanical refrigeration systems, etc. will be installed.

Mo., Sedalia—City, N. C. Nelson, Clk., will soon award contract for the construction of a sewage disposal plant and pump house. Estimated cost $150,000. Burns & McDonald, 400 Interstate Bldg., Kansas City, are engineers.

N. Y., Albany — Central Railway Terminal & Cold Storage Co. Inc., c/o Moores & Dunford Inc., 110 East 42nd St., New York, Archts., awarded contract for the construction of a cold and dry storage warehouse at Montgomery, Colonie and Center Sts., here, to Parklap Construction Corp., 84 Pine St., New York. Estimated cost $2,000,000.

N. Y., New York—Central Savings Bank, 100 East 14th St., awarded contract for the construction of a 5 story bank and office building at Broadway and 73rd to 74th Sts. to Hegeman-Harris Co., Inc., 360 Madison Ave. Estimated cost $3,000,000. Steam heating system, boilers, elevators, etc. will be installed.

N. Y., New York—H. A. Hyman Inc., 50 East 42nd St., will build a 12 story apartment building at 10th St. and University Pl. Estimated cost $500,000. E. Roth, 1440 Broadway, is architect. Steam heating and ventilation systems, boilers, elevators, etc. will be installed. Work will be done by separate contracts.

N. Y., New York—Sixty First St. and Broadway Corp., W. Kaufman, Pres., 1440 Broadway, will build a 17 story office building. Estimated cost $550,000. E. Roth, 1440 Broadway, is architect. Steam heating system, boilers, elevators, etc. will be installed. Work will be done by separate contracts.

N. Y., New York—J. Stewart Realty Co., 17 East 42nd St., is having plans prepared for the construction of an 18 story loft building including steam heating system, boilers, elevators, etc. at 128 West 30th St. C. Gilbert, 244 Madison Ave., is architect.

O., Cleveland—New York, Chicago & St. Louis R.R. Co., Prospect Ave. and East 2nd St., awarded contract for the design and construction of a warehouse including boiler room, etc. to The Austin Co., 16112 Euclid Ave. A. C. Harvey, is chief engineer.

O., Dayton—H. G. Cornell, 129 West First St., plans the construction of an art institute including separate heating plant, etc. at Forest and Riverview Sts. Estimated cost $1,000,000. A. H. Hopkins, 451 Main St., Buffalo, N. Y., is architect.

Okla., Purcell—City plans an election May 3 to vote $80,000 bonds for the construction of an electric light plant including two 400 hp. Diesel oil engines and generators, etc. H. E. Mussoy, Oklahoma City, is engineer.

Okla., Seminole—City plans an election May 16 to vote $65,000 bonds for waterworks improvements including three deep well pumps and motors, etc. Long & Co., 1300 Colcord Bldg., Oklahoma City, are engineers.

Pa., Chester — G. J. Hunter, Supt. of Streets & Public Improvements, will receive bids until May 10, for the construction of a pumping station at West Second St. and Chester River. R. C. Wheeler, 36 State St., Albany, N. Y., is consulting engineer.

Pa., Darby—Green & Albman, Heyman Bldg., Philadelphia plans the construction of an 11 story office and theatre building on Park Ave. here. Estimated cost $1,000,000. W. H. Lee, Schaff Bldg., Philadelphia, is architect.

Pa., Greensburg — West Pennsylvania Power Co., 18 Wood St., Pittsburgh, plans the construction of a sub-station here. Estimated cost $70,000. Private plans.

Pa., Pittsburgh—Associated Doctors Hospital, c/o J. F. Kuntz, Westinghouse Bldg., Archt., is having preliminary plans prepared for the construction of a 13 story hospital. Estimated cost $750,000.

Pa., Wilkes-Barre—Miner's Bank, will soon contract for the construction of a 16 story bank and office building. Estimated cost $1,000,000. W. L. Stoddart, 50 East 41st St., New York, N. Y., is architect.

Pa., Wilmerding—Duquesne Light Co., 435 6th Ave., Pittsburgh, will build a substation here. Estimated cost $50,000. Private plans. Work will be done by separate contracts.

Texas—W. Burns, Harlingen, will build cold storage plants at Weslaco, Harlingen and San Benito by day labor. Total estimated cost $100,000.

Tex., Austin — University of Texas, awarded contract for the construction of a power plant to James T. Taylor Co., First National Bldg., Ft. Worth. Estimated cost $218,500.

Tex., Beaumont—Owner, c/o J. C. Beck, 218 San Jacinto Life Bldg., Archt. is having preliminary plans prepared for the construction of a 16 story hotel including steam heating, refrigeration and ventilation systems, boilers, elevators, etc. at Liberty Ave. and Broadway. Estimated cost $1,000,000.

Tex., Big Lake—West Texas Utilities Co., Abilene, has acquired the ice and light plants of the Big Lake Utilities Co., and plans extensions and improvements here. Estimated cost $35,000. Private plans. Machinery for both plants will be required.

Tex., Dallas—Southwestern Bell Telephone Co., 11th and Pine Sts., St. Louis, Mo., awarded contract for the construction of a 16 story office building here. Estimated cost $2,500,000.

Tex., McAllen—Rio Grande Valley Cold Storage Co., is having plans prepared for the construction of a cold storage plant. Estimated cost $65,000. Private plans. Machinery will be required.

Tex., San Angelo—Pecos Valley Utilities Co., subsidiary of Kansas City Power & Light Co., 14th St. and Grand Ave., Kansas City, Mo., is having surveys made for the construction of a dam on the Pecos River below San Angelo for power purposes. Estimated cost $200,000. Private plans.

Tex., San Angelo—San Angelo Refining Co., plans extensions and improvements to refinery, also installation of additional machinery in power plant to increase the capacity. Estimated cost $75,000. Private plans. Work will be done by owner's forces.

Va., Hopewell—City plans the construction of an electric light plant in connection with the Allied Chemical Co.'s development, here. Estimated cost $10,000,000.

B. C., Grand Forks—City is having plans prepared for the construction of a dam, 7,000 kw. capacity. Estimated cost $200,000. A. L. McCulloch, Nelson, is engineer.

Man., Fort Alexander—Manitoba Power Co., plans the construction of a 28,000 kw. generating unit at Great Falls plant.

Ont., Ottawa—City plans the construction of a filtration plant in connection with waterworks including filters, pumps, electric motors, etc. Estimated cost $1,000,000. A. F. Macallum, City Hall, is engineer.

Equipment Wanted

Boilers—Park Dept., W. P. Long, Chn., 33 Beacon St., Boston, Mass., will receive bids until May 5, for furnishing new steam boiler at North End Park.

Boilers — U. S. Government, Treasury Dept., Washington, D. C., will receive bids until May 16, for the installation of new boilers in Maine Hospital at Portland, Me.

Condenser—B. Chamberlain, Clk., Pasadena, Calif., will receive bids until May 17, for a steam surface condenser, auxiliary equipment and appurtenances for power plant.

Engine and Generator—City of Marlow, Okla., plans to purchase a 400 hp. Diesel engine and electric generator. Estimated cost $28,000.

Engine and Motor—Springhope Cotton Oil Co., Springhope, N. C., is in the market for 200 to 300 kva., 60 cycle oil engine set and 10 to 75 hp. motors.

Generator, Etc.—Bd. of Public Service, St. Louis, Mo., will receive bids until May 24, for four forced draft and two inducted draft fans, one gasoline driven, a.c. generator, etc., for Howard's Bend waterworks.

Heating Equipment — Dept. of Public Works, S. E. O'Brien, Secy., Ottawa, Ont., will receive bids until May 17, for alterations to heating equipment for centralization of heating apparatus in Post Office, Examining Warehouse and Winch building at Vancouver, B. C.

Pumping Equipment, Etc.—City of Many, La., will soon receive bids for pumping equipment, etc. for proposed waterworks improvements. Estimated cost $50,000.

Pump—City of Bernice, Okla., will be in the market for a deep well pump for proposed new waterworks system. Estimated cost $17,000.

Pump—City of Mooreland, Okla., will be in the market for a deep well pump, etc., for proposed waterworks improvements. Estimated cost $25,000.

Pump and Motor—City of Gotebo, Okla., H. Justus, Mayor, will be in the market for triplex pump and motor for proposed improvements to waterworks. Estimated cost $30,000.

Pumps, Etc.—Dept. of Mental Hygiene, Capitol, Albany, N. Y., will receive bids until May 11 for furnishing and installing pumps, etc. at St. Lawrence State Hospital, Ogdensburg, N. Y.

Refrigeration System, Etc. — Bd. of Trustees, Ohio State University, C. E. Steeb, Secy., Columbus, O., is in the market for a mechanical refrigeration system.

Regulators—W. H. Duffy, Dir. of Service, City Hall, Columbus, O., is in the market for two single ph. induction feeder voltage regulators.

Water Wheels, Etc.—B. R. Power Co., Clifton Station, Va., is in the market for two turbine water wheels, shafting harness work, 100 to 250 hp., 15 or 20 ft. head, 2 a.c., 60 cycle, 3 ph., 2,300 v. alternators, switchboard, etc.

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